PUBLICATIONS

OF THE

LICK OBSERVATORY

VOL. VIII – 1908

NOTE.

In the original negatives of subjects 10 and 12, there are faint dark rings immediately surrounding some of the stars in the denser parts of the nebulosity. This effect has no doubt been accentuated in the subsequent photographic processes. On the plates of these two subjects in the completed volume, these rings are very distinct and give rise to a suspicion that the effect has been enhanced by the engraver. A critical examination of the prints seems to confirm this view. In the original proofs these rings were inconspicuous and were not noticed. The processes of steel-facing and printing appear to have increased the effect markedly, as it is much stronger on the sheets printed for the edition than in any of the early proofs.

Inasmuch as these effects were not and could not be discovered until the sheets were assembled in Sacramento for binding, it has not been thought desirable to delay the issue of the volume for several weeks additional in order to have new plates and new prints of these subjects made by the distant engraver.

Lick Observatory,
Mount Hamilton,
November, 1908.

Plate 10

THE GREAT NEBULA IN ORION

UNIVERSITY OF CALIFORNIA PUBLICATIONS

PUBLICATIONS

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LICK OBSERVATORY

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VOLUME VIII

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1908

As a Tribute to the Memory of

JAMES EDWARD KEELER

and in recognition of his great worth as a man and as an astronomer, the plates for this volume have been provided by

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PHOTOGRAPHS OF NEBULÆ AND CLUSTERS,

MADE WITH

THE CROSSLEY REFLECTOR,

BY

JAMES EDWARD KEELER,
DIRECTOR OF THE LICK OBSERVATORY,
1898-1900.

PREFACE.

When Professor Keeler entered upon the duties of Director of the Lick Observatory, on June 1, 1898, he planned to devote his observing time for several years to photographing the brighter nebulæ and star clusters, with the Crossley reflector. The story of his wonderful success with this difficult instrument is familiar to all readers of astronomical literature: this form of telescope was in effect born again; and his contributions to our knowledge of the nebulæ were epoch-making.

Professor Keeler's observing programme included one hundred and four subjects. At the time of his lamented death, on August 12, 1900, satisfactory negatives of two-thirds of the selected objects had been secured. The unphotographed objects were mainly those which come into observing position in the unfavorable winter and spring months. The completion of the programme was entrusted to Assistant Astronomer Perrine. The observers were assisted chiefly by Mr. H. K. Palmer, and in smaller degree by Messrs. Joel Stebbins, C. G. Dall, R. H. Curtiss and Sebastian Albrecht.

Professor Keeler's photographs enabled him to make two discoveries of prime importance, not to mention several that are scarcely secondary to them.

1st.—" Many thousands of unrecorded nebulæ exist in the sky. A conservative estimate places the number within reach of the Crossley reflector at about 120,000. The number of nebulæ in our catalogues is but a small fraction of this." [The number already discovered and catalogued did not exceed 13,000. Later observations with the Crossley reflector, with longer exposure-times and more sensitive plates, render it probable that the number of nebulæ discoverable with this powerful instrument is of the order of half a million.]

2d.—" Most of these nebulæ have a spiral structure."

The photographs of the one hundred and four subjects contain the images of 744 nebulæ not previously observed. A catalogue of these is published in the present volume. Their positions, which are thought to be accurate within 1″, were determined by Messrs. Palmer, Curtiss, and Albrecht.

The main purpose of this volume is to reproduce and make available for study, the larger and more interesting nebulæ and clusters on the programme, sixty-eight in number. The thirty-six subjects not reproduced are for the most part small or apparently not of special interest. The difficulties attending the reproduction of astronomical photographs by mechanical processes are well-known to all who have made the attempt. It seems necessary to recognize, at least at present, that delicate details of structure will be lost, and that contrasts between very bright and very faint regions will be changed, especially if a good sky background is preserved; in other words, that the best obtainable reproductions fall far short of doing justice to the original photographs. Technical studies should be based upon the original negatives or upon copies on glass.

After considerable experimental work, involving several methods and several firms, the making of the heliogravure plates and the hand-press prints was entrusted to The Photogravure and Color Company of New York City. To this firm's continued interest and willingness to act on constructive criticism is due much of the excellence of the results.

The expensive reproductions could hardly have been undertaken without the generous assistance of the donors mentioned on a preceding page.

Professor Keeler's description of the Crossley reflector, of his methods of observing, and of the chief results obtained, was written only a short time before his death. It is here republished. Other results of his work are described in the several papers to which the footnotes refer.

TABLE OF CONTENTS.

2—P

THE CROSSLEY REFLECTOR OF THE LICK OBSERVATORY.*

By James E. Keeler.

The Crossley reflector, at present the largest instrument of its class in America, was made in 1879 by Dr. A. A. Common, of London, in order to carry out, and test by practical observation, certain ideas of his respecting the design of large reflecting telescopes. For the construction of the instrument embodying these ideas, and for some fine astronomical photographs obtained with it, Dr. Common was awarded the gold medal of the Royal Astronomical Society in 1884.

In 1885, Dr. Common, wishing to make a larger telescope on a somewhat similar plan, sold the instrument to Edward Crossley, Esq., F. R. A. S., of Halifax, England. Mr. Crossley provided the telescope with a dome of the usual form, in place of the sliding roof used by its former owner, and made observations with it for some years; but the climate of Halifax not being suitable for the best use of such a telescope, he consented, at the request of Dr. Holden, then Director of the Lick Observatory, to present it to this institution. The funds for transporting the telescope and dome to California, and setting them up on Mount Hamilton, were subscribed by friends of the Lick Observatory, for the most part citizens of California. The work was completed, and the telescope housed in a suitable observatory building, in 1895.[1]

On taking charge of the Lick Observatory in 1898, I decided to devote my own observing time to the Crossley reflector, although the whole of my previous experience had been with refracting telescopes. I was more particularly desirous of testing the reflector with my own hands, because such preliminary trials of it as had been made had given rise to somewhat conflicting opinions as to its merits.[2] The result of my experience is given in the following article, which is written chiefly with reference to American readers. If I have taken occasion to point out what I regard as defects in the design or construction of the instrument, I have done so, not from any desire to look a gift horse in the mouth, but in the interest of future improvement, and to make intelligible the circumstances under which the work of the reflector is now being done and will be done hereafter. The most important improvements which have suggested themselves have indeed already

* Reprinted from *The Astrophysical Journal*, **11**, 325, 1900.

[1] For a more complete history of this part of the subject, see Dr. Holden's articles in *Pub. Ast. Soc. Pacific*, **7**, 197 *et seq.*, 1895.

[2] The difficulties here referred to, about which a good deal has been written, seem to have had their origin in the fact that it was impossible, at the time of the preliminary trials, to provide the observer with an assistant, while the Crossley reflector is practically unmanageable by a single person.

been made by Dr. Common himself, in constructing his five-foot telescope. The three-foot reflector is, in spite of numerous idiosyncracies which make its management very different from the comparatively simple manipulation of a refractor, by far the most effective instrument in the Observatory for certain classes of astronomical work. Certainly no one has more reason than I to appreciate the great value of Mr. Crossley's generous gift.

The Crossley dome is about 350 yards from the main Observatory, at the end

DOME OF THE CROSSLEY REFLECTOR.

of a long rocky spur which extends from the Observatory summit toward the south, and on which are two of the houses occupied by members of the Observatory staff. It is below the level of the lowest reservoir, "Huyghens," which receives the discharge from the hydraulic machinery of the 36-inch refractor, and therefore the water engine furnished by Mr. Crossley for turning the dome can not be used, unless a new water system—overflow reservoir, pump and windmill—is provided. In this respect a better site would have been a point on the south slope of "Kepler,"—the middle peak of Mount Hamilton—just above the Huyghens reservoir. No addition to the present water system would then have been needed. The slope of the mountain at this place might cut off the view of the north horizon, but since the telescope can not be turned below the pole, this would be a matter of no consequence. Water-power for the dome is not, however, really necessary.

The cylindrical walls of the dome, 36¼ feet inside diameter, are double, and provided with ventilators. Opening into the dome, on the left of the entrance, are three small rooms, one of which has been fitted up as a photographic dark room, and another, containing a sidereal clock and a telephone, which communicates with the main Observatory, as a study, while the third is used for tools and storage. There is also a small room for the water engine, in case it should be used. The dome is at present supplied with water from only the middle reservoir, Kepler, which is reserved for domestic purposes and is not allowed to pass through the machinery.

The dome itself, 38 feet 9 inches in diameter, is made of sheet-iron plates riveted to iron girders. It also carries the wooden gallery, ladders, and observing platform, which are suspended from it by iron rods. The apparatus for turning the dome consists of a cast-iron circular rack bolted to the lower side of the sole-plate, and a set of gears terminating in a sprocket-wheel, from which hangs an endless rope. As the dome does not turn easily, it has been necessary to multiply the gearing of the mechanism so that one arm's-length pull on the rope moves the dome only about one inch. In some positions of the telescope the dome can not be moved more than six or eight inches at a time without danger of striking the tube, and this slowness of motion is then not disadvantageous. It is only when the dome has to be moved through a considerable angle, as in turning to a fresh object, or in photographing some object which passes nearly through the zenith, that the need for a mechanical means of rotation is felt.

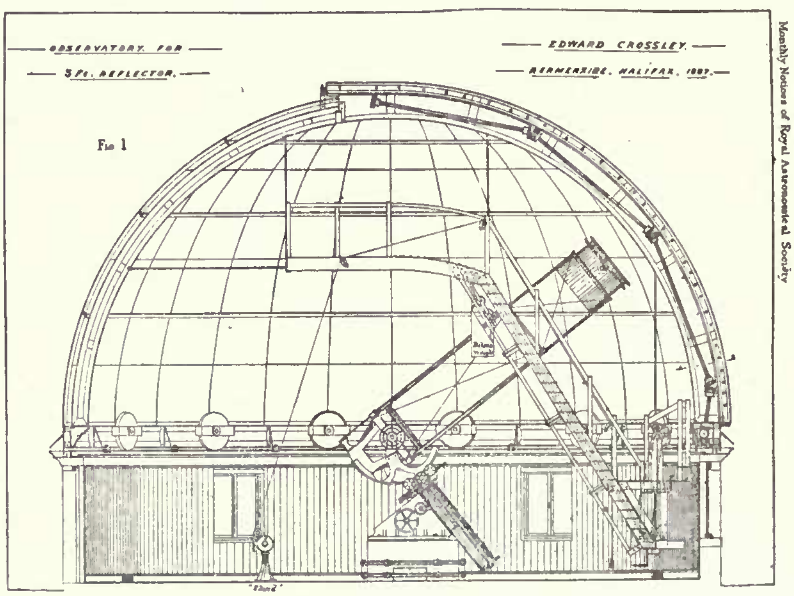
The observing slit, 6 feet wide, extends considerably beyond the zenith. It is closed by a double shutter, which is operated by an endless rope. The upper part, within the dome, is also closed by a hood, or shield, which serves to protect the telescope from any water that may find its way through the shutter, and which is rolled back to the north when observations are made near the zenith. I have recently fitted the lower half of the slit with a wind-screen, which has proved to be a most useful addition. It is made of tarpaulin, attached to slats which slide between the two main girders, and is raised or lowered by halliards, which belay to cleats on the north rail of the gallery. A more detailed description of the dome has been given in an article by Mr. Crossley,[1] from which the reduced figure in Fig. 1[2] has been taken.

The mounting of the three-foot reflector has been very completely described and illustrated by Dr. Common,[3] so that only a very general description need be

[1] *Mon. Not. R. A. S.*, **48**, 386.
[2] Kindly lent by the Astronomical Society of the Pacific.
[3] *Mem. R. A. S.*, **46**, 173.

given here. The most important feature of the mounting is that the telescope tube, instead of being on one side of the polar axis, as in the usual construction, is central, so that the axis of the mirror and the polar axis are in the same line when the telescope is directed to the pole. The declination axis is short, and is supported by a massive goose-neck bolted to the upper end of the polar axis. The mirror is placed just *above* the declination axis. Its weight, and the weight of the whole tube and eye-end, are counterpoised by slabs of lead, placed in two iron boxes, between which the goose-neck of the polar axis passes. The great advantage of this arrangement, and the controlling principle of the design, is that the telescope is perfectly free to pass the meridian at all zenith distances. No reversal of the instrument is needed, or is indeed possible.

For long-exposure photography, the advantage above referred to is obvious,



THE CROSSLEY REFLECTOR.

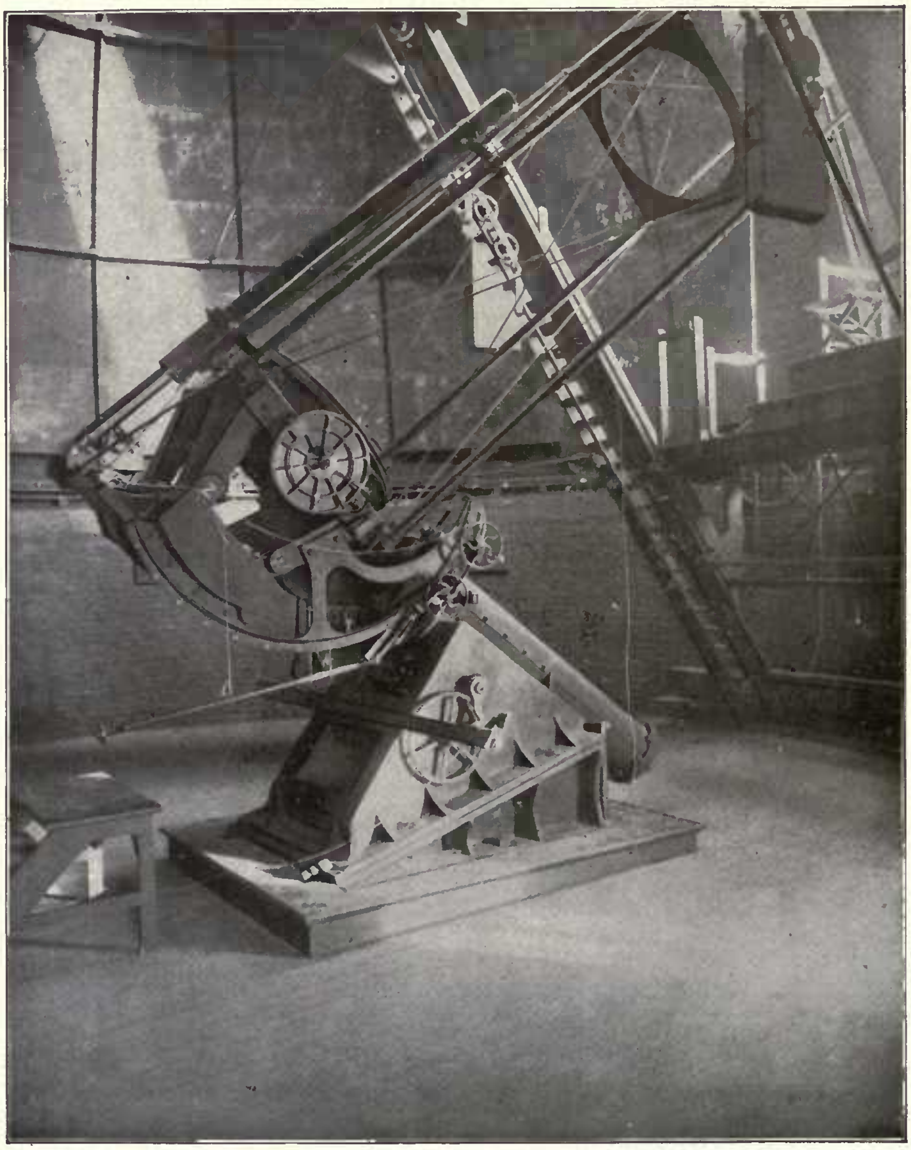
but it is attended by certain disadvantages. One of these is that a very much larger dome is required than for the usual form of mounting. Another is the great amount of dead weight which the axes must carry; for the mirror, instead of helping to counterpoise the upper end of the tube, must itself be counterpoised. When anything is attached to the eye-end (and in astrophysical work one is always attaching things to the eye-end of a telescope), from ten to twenty times as much weight must be placed in the counterpoise boxes below the declination axis. Where room is to be found for the weights required to counterpoise the Bruce spectrograph, is a problem which I have not yet succeeded in solving.

In his five-foot reflector, Dr. Common has caused the telescope tube to swing between two large ears, which project from the upper end of the boiler-like polar axis, the pivots constituting the declination axis being near, but above, the lower end of the tube. The mirror, therefore, helps to counterpoise the upper end of the tube. This I regard as a distinct improvement. The danger of large masses of metal near the mirror injuring the definition is, in my opinion, imaginary; at least there is no such danger on Mount Hamilton, where the temperature variations are unusually small. Experience with the Crossley reflector, as well as with the other instruments of the Lick Observatory, shows that the definition depends almost entirely on external conditions.

My first trials of the reflector, as first mounted at the Lick Observatory, showed that the center of motion was inconveniently high. Among other difficulties arising from this circumstance, the spectroscope projected beyond the top of the dome, so that it had to be removed before the shutter could be closed. In July, 1898, the pier was therefore cut down two feet. This brought the eye-end down nearly to the level of the gallery rail, where it was at a convenient height for the observer when sitting on a camp-stool, and it made all parts of the mounting more accessible. Toward the north and south, the range of the telescope, being limited in these directions by the construction of the mounting, was not affected by the change, but the telescope can not now be used at such low altitudes as formerly, near the east and west points of the horizon. The only occasion likely to call for the use of the reflector in these positions is the appearance of a large comet near the Sun, and, after some consideration, I decided to sacrifice these chances for the sake of increasing the general usefulness of the instrument. Except in rare cases, all observations are made within three hours of the meridian.

To adapt the mounting to the latitude of Mount Hamilton, a wedge-shaped casting, shown in the illustration, had been provided, but through some error, arising probably from the fact that the telescope had been used in two different latitudes in England, the angle of the casting was too great. When the pier was cut down its upper surface was therefore sloped toward the south, in order to compensate the error in the casting. Plate VII shows the instrument very nearly as it is at the present time.

The polar axis of the Crossley reflector is a long, hollow cylinder, separated by a space of about one-eighth of an inch from its concentric casing. The idea was to fill this space with mercury, and float the greater part of the thrust of the axis, the function of a small steel pin at the lower end being merely to steady the axis. But this mercury flotation, as applied to the Crossley telescope, is a delusion, as I think Mr. Crossley had already found. The mercury, it is true, relieves the thrust to some extent, but it greatly increases the already enormous side pressure on the steel pin at the bottom, thus creating a much greater evil than the one it is intended to remedy. The workmen who set up the mounting inform me that the small bearing at the lower end of the polar axis is badly worn, as I should expect it to be. Instead of putting mercury into the space intended for it, I have therefore poured in a pint or so of oil, to keep the lower bearing lubricated. For the reasons indicated above, the force required to move the telescope in right ascension is perhaps five times greater than it should be. The lower end of the polar axis ought to be fitted with ball bearings to take the thrust, and with a pair of friction wheels on top; but it would be difficult to make these changes now. It should be observed that the disadvantages of the mercury flotation are consider-



THE CROSSLEY REFLECTOR.

ably greater at Mount Hamilton than at the latitude for which the telescope was designed.

As already stated above, the range of the telescope is limited on the south by the construction of the mounting. The greatest southern declination which can be observed is 25°. In England this would doubtless mark the limit set by atmospheric conditions, but at Mount Hamilton it would be easy to photograph objects 15° farther south, if the telescope could be pointed to them.

The original driving-clock having proved to be inefficient, at least without an electric control, a new and powerful driving-clock was made by the Observatory instrument maker, from designs by Professor Hussey. In its general plan it is like that of the 36-inch refractor. The winding apparatus, contained in the large casting of the original mounting, has no maintaining power, and can not easily be fitted with one. The clock could in no case be wound during a photographic exposure, on account of the tremors attending the operation, but it would be somewhat more convenient to have the stars remain on the plate during the winding. With a little practice, however, one can wind the clock without actually stopping it, though the object must afterwards be brought back to its place by means of the slow motion in right ascension.

Two finders have recently been fitted to the Crossley reflector. One has an object-glass of four inches aperture and eight feet six inches focal length, with a field of about 1° 2′, which is very nearly the photographic field of the main telescope. Its standards are bolted to one of the corner tubes of the reflector. The other finder has a three-inch objective and a large field. It had not been mounted when the photograph for the plate was made.

When a telescope is used for photographing objects near the pole, with long exposures, the polar axis must be quite accurately adjusted, for otherwise the centers of motion of the stars and of the telescope will not agree, and the star images will be distorted. It is true that with a double-slide plate-holder, like the one used with the Crossley reflector, one star—namely, the guiding star—is forced to remain in a fixed position with respect to the plate; but the differential motion of the other stars causes them to describe short arcs, or trails, around this star as a center. A considerable part of the spring of 1899 was spent in efforts to perfect the adjustment of the polar axis, an operation which, on account of the peculiar form of the mounting, offers unusual difficulties.

In the first plan which was tried, the reflector was used as a transit instrument. The inclination of the declination axis was determined with a hanging level which had been provided by Mr. Crossley, the hour circle and polar axis being very firmly clamped. The clock correction being known from the records kept at the Observatory, the collimation and azimuth constants were found by the usual formulæ. This method failed to give satisfactory results, and it was found later that the declination and polar axis were not exactly at right angles.

There is only one part of the sky on which the telescope can be reversed; namely, the pole. A method which promised well, and on which some time was spent, consists in photographing the pole (the declination axis being horizontal) by allowing the stars near it to trail for ten or fifteen minutes, then turning the polar axis 180° and photographing the pole again on the same plate. Half the distance between the images gives the error of the polar axis, which, if the plate is properly oriented, is easily resolved into horizontal and vertical components;

while the distance of each image from the center of the plate is this error increased or diminished by twice the deviation of the telescope axis. In this case the vertical component depends upon the reading of the declination circle, and the horizontal component gives the error of collimation. This method failed, however, to give consistent results, mainly on account of instability of the mirror, and was abandoned.

The use of the large mirror for purposes of adjustment was finally given up, and the axis was adjusted by observations of *Polaris* with the long finder, in the usual manner. In order to reach the star at lower culmination the finder tube had to be thrown out of parallelism with the main telescope.

The base-plate having no definite center of rotation in azimuth, and the wedges and crowbars used for moving it being uncertain in their action, a watch telescope, provided with a micrometer eyepiece, was firmly secured to the mounting throughout these operations, in such manner that a mark on the southern horizon could be observed through one of the windows of the dome. The errors of the polar axis were finally reduced to within the limits of error of observation.

The movable hour circle and driving wheel of the Crossley reflector has two sets of graduations. The driving screw having been thrown out of gear, the circle is turned until the outer vernier indicates the sidereal time, whereupon the driving screw is thrown into gear again. The inner vernier is then set to the right ascension of the object which it is desired to observe. As an inconsistency, of minor importance, in the design of the mounting, I may note that the slow motion in right ascension changes the reading of the outer vernier instead of that of the inner one. In practice, however, no inconvenience is caused by this construction.

In the early experiments and photographic work with the Crossley telescope, irregularities in driving were a source of great annoyance. Dr. Roberts, in laying down the conditions which should be fulfilled by a good photographic telescope, says that a star should remain bisected by a thread in the eyepiece for two minutes at a time. The Crossley telescope was so far from fulfilling this condition that a star would not keep its place for two consecutive seconds; and the greatest alertness on the part of the observer did not suffice to ensure round star images on a photographic plate. It was obvious that the fault did not lie with the driving clock; in fact, many of the sudden jumps in right ascension, if explained in this way, would have required the clock to run backward; nevertheless the clock was tested by causing its revolutions to be recorded on a chronograph at the main Observatory, together with the beats of one of the standard clocks. For this purpose a break-circuit attachment was made by Mr. Palmer. The errors of the clock were in this way found to be quite small.

The principal source of the irregularities was found in the concealed upper differential wheel of the Grubb slow motion. This wheel turned with uncertain friction, sometimes rotating on its axis, and sometimes remaining at rest. After it was checked the driving was much better, and was still farther improved by repairing some defective parts of the train. Small irregularities still remain. They seem to be partly due to inaccuracies in the cutting of the gears, or of the teeth of the large driving wheel, and partly to the springing of the various parts, due to the very considerable friction of the polar axis in its bearings. The remaining irregularities are so small, however, that they are easily corrected by the screws of the sliding plate-holder, and with reasonable attention on the part of the observer, round star images are obtained with exposures of four hours' duration.

The large mirror, the most important part of the telescope, has an aperture of three feet, and a focal length of 17 feet 6.1 inches. It was made by Mr. Calver. Its figure is excellent. On cutting off the cone of rays from a star, by a knife-edge at the focus, according to the method of Foucault, the illumination of the mirror is very uniform, while the star disks as seen in an ordinary eyepiece are small and almost perfectly round. They are not, I think, quite so good as the images seen with a large refractor; still, they are very good indeed, as the following observations of double stars, made recently for this purpose, will show.

Several close double stars were examined on the night of April 17, 1900, with a power of 620. The seeing was four on a scale of five. The magnitudes and distances of the components, as given in the table, are from recent observations by Professor Hussey with the 36-inch refractor.

Star.	Mag.	*d.*	Result of Obs.
OΣ 208 (*φ Urs. Maj.*)	5.0, 5.5	0″.35	Not resolved ; too bright.
OΣ 249, AB	7.2, 8.0	0 .54	Easily resolved.
OΣ 250	7.7, 8.0	0 .44	Resolved.
OΣ 267	8.0, 8.2	0 .30	Just resolved at best moments.

Although the theoretical limit of resolution for a three-foot aperture is not reached in these observations, I do not think the mirror can do any better.

The small mirror, or flat, at the upper end of the tube, is circular, the diameter being nine inches. Its projection on the plane of the photographic plate is therefore elliptical; but the projection of the mirror and its cell on the plane of the great mirror is very nearly circular.

The small mirror, acting as a central stop, has the effect of diminishing the size of the central disk of the diffraction pattern, at the expense of an increase in the brightness of the system of rings. To this effect may be due, in part, the inferiority of the reflector for resolving bright doubles, as compared with a refractor of the same aperture. For photographic purposes, it is evident that the mirror is practically perfect.

The upper end of the tube can be rotated, carrying with it the flat and the eye-end. Whenever the position is changed, the mirrors have to be re-collimated. In practice it is seldom necessary to touch the adjusting screws of the mirrors themselves. The adjustment is effected by means of clamping and butting screws on the eye-end, and a change of the line of collimation, with respect to the finders and the circles, is avoided. The operation is generally referred to, however, as an adjustment of the mirrors.

For adjusting the mirrors there are two collimators. One of these is of the form devised by Mr. Crossley.[1] It is very convenient in use, and is sufficiently accurate for the adjustment of the eye-end when the telescope is used for photographic purposes, inasmuch as the exact place where the axis of the large mirror cuts the photographic plate is not then a matter of great importance, so long as it is near the center. Moreover, as stated farther below, the direction of the axis changes during a long exposure. The other collimator is of a form originally due, I think, to Dr. Johnstone Stoney. It consists of a small telescope, which fits the draw-tube at the eye-end. In the focus of the eyepiece are, instead of cross-wires, two adjustable terminals, between which an electric spark can be passed, generated by a small induction machine, like a replenisher, held in the observer's hand. The terminals are at such a distance inside the principal focus of the objective, that the light from the spark, after reflection from the flat, appears to proceed from the center of curvature of the large mirror. The rays are therefore reflected back normally, and form an image of the spark which, when the mirrors are in perfect adjustment, coincides with the spark itself. The precision of this method is very great. It is in fact out of proportion to the degree of refinement attained in other adjustments of the reflector, for a slight pressure of the hand on the draw-tube, or movement of the telescope to a different altitude, instantly destroys the perfection of the adjustment. I have provided these collimators with an adapter which fits the photographic apparatus, so that one can adjust the mirrors without having to remove this apparatus and substitute for it the ordinary eye-end carrying the eyepieces.

For visual observation the Crossley telescope is provided with seven eyepieces, with powers ranging from 620 downward. The lowest power is only 60, and consequently utilizes only 12 inches of the mirror, 9 of which are covered by the central flat. It is therefore of little value, except for finding purposes. The next lowest power utilizes 28 inches of the mirror. The other eyepieces call for no remark.

But, while the Crossley reflector would doubtless be serviceable for various kinds of visual observations, its photographic applications are regarded as having the most importance, and have been chiefly considered in deciding upon the different changes and improvements which have been made.

The interior of the dome is lighted at night by a large lamp, which is enclosed in a suitable box or lantern, fitted with panes of red glass, and mounted on a portable stand. In order to diffuse the light in the lower part of the dome, where most

[1] *Mon. Not. R. A. S.*, **48**, 280, 1888.

of the assistant's work is done, the walls are painted bright red; while to prevent reflected light from reaching the photographic plate, the inner surface of the dome itself, the mounting, and the ladders and gallery are painted dead black. The observer is therefore in comparative darkness, and not the slightest fogging of the plate, from the red light below, is produced during a four-hours' exposure. On the few occasions when orthochromatic plates are used the lamp need not be lighted.

Experiments have shown that the fogging of the photographic plate, during a long exposure, is entirely due to diffuse light from the sky, aud is therefore unavoidable. For this reason the cloth curtains which lace to the corners of the telescope tube, enclosing it and shutting out light from the lower part of the dome, have not been used, since their only effect would be to catch the wind and cause vibrations of the telescope. They would probably have little effect on the definition, and at any rate could not be expected to improve it.

For photographing stars and nebulæ the Crossley reflector is provided with a double-slide plate-holder, of the form invented by Dr. Common.[1] This apparatus, which had suffered considerably in transportation, and from general wear and tear, was thoroughly overhauled by the Observatory instrument-maker. The plates were straightened and the slides refitted. A spring was introduced to oppose the right ascension screw and take up the lost motion — the most annoying defect that such a piece of apparatus can have — and various other improvements were made, as the necessity for them became apparent. They are described in detail farther below.

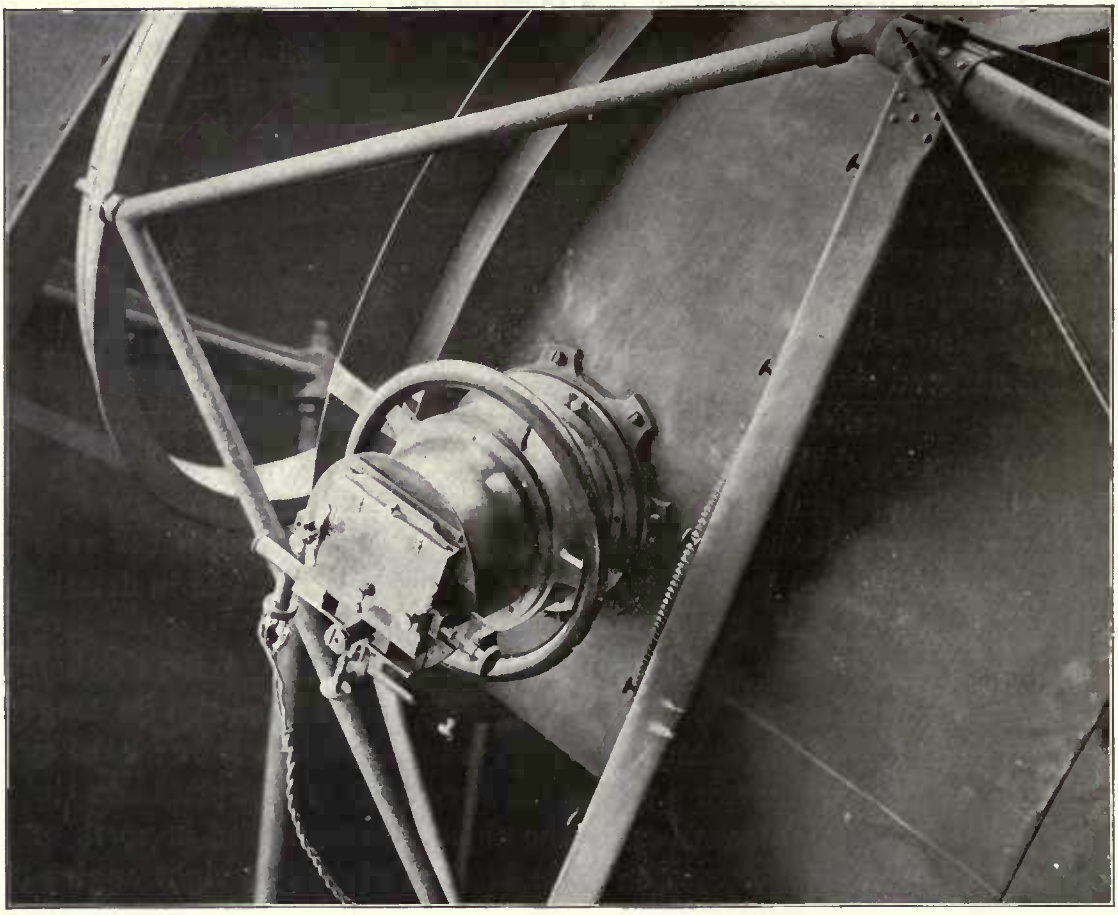
The present appearance of the eye-end is shown in the illustration. The plate-holder is there shown, however, on one side of the tube, and its longer side is parallel to the axis of the telescope. This is not a good position for the eye-end, except for short exposures. In practice, the eye-end is always placed on the north or south side of the tube, according as the object photographed is north or south of the zenith. The right ascension slide is then always at right angles to the telescope axis, and the eye-end can not get into an inaccessible position during a long exposure.

As the original wooden plate-holders were warped, and could not be depended upon to remain in the same position for several hours at a time, they were replaced by new ones of metal, and clamping screws were added, to hold them firmly in place. The heads of these screws are shown in the plate, between the springs which press the plate-holder against its bed.

To illuminate the cross-wires of the guiding eyepiece, a small electric lamp is used, the current for which is brought down from the storage battery at the main

[1] *Mon. Not. R. A. S.*, **49**, 297. The construction here described is not followed exactly in the Crossley apparatus. The guiding eyepiece slides freely when not held by a clamp. Pin-holes for preventing fogging are unnecessary when red light is used.

Observatory. The coarse wires have been replaced by spider's webs,[1] and reflectors have been introduced, to illuminate the declination thread. A collimating lens, placed at its principal focal distance from the incandescent filament of the lamp, makes the illumination of the wires nearly independent of their position on the slide, and a piece of red glass, close to the lens, effectually removes all danger of fogging the plate. The light is varied to suit the requirements of



DOUBLE-SLIDE PLATE-HOLDER OF THE CROSSLEY REFLECTOR.

observation by rotating the reflector which throws the light in the direction of the eyepiece.

In long exposures it is important for the observer to know at any moment the position of the plate with reference to its central or zero position. For this purpose scales with indexes are attached to both slides; but as they can not be seen in the dark, and, even if illuminated with red light, could not be read without removing the eye from the guiding eyepiece, I have added two short pins, one of

[1] It so happens that the tension of the vertical thread is such that it begins to slacken when the temperature falls to within about 2° of the dew point. The thread thus forms an excellent hygrometer, which is constantly under the eye of the observer. When the thread becomes slack, it is time to cover the mirrors.

which is attached to the lower side of the right ascension slide, and the other to its guide, so that the points coincide when the scale reads zero. These pins can be felt by the fingers, and with a little practice the observer can tell very closely how far the plate is from its central position. It would not be a very difficult matter to improve on this contrivance, say by placing an illuminated scale, capable of independent adjustment, in the field of the eyepiece, but the pins answer every purpose. The declination slide is changed so little that no means for indicating its position are necessary.

In this apparatus, as originally constructed, the cross-wires of the guiding eyepiece were exactly in the plane of the photographic plate. The earlier observations made with the Crossley reflector on Mount Hamilton showed that this is not the best position of the cross-wires. The image of a star in the guiding eyepiece, which, when in the middle of its slide, is nearly three inches from the axis of the mirror, is not round, and its shape varies as the eyepiece is pushed in or drawn out. In the plane of the photographic plate (assumed to be accurately in focus), it is a crescent, with the convex side directed toward the center of the plate. This form of image is not suitable for accurate guiding. Outside this position the image changes to an arrow-head, the point of which is directed toward the axis, and this image can be very accurately bisected by the right ascension thread. As the construction of the apparatus did not allow the plane of the cross-wires to be changed, the wooden bed of the plate-holder was cut down, so as to bring the wires and the plate into the proper relative positions.

After some further experience with the instrument, still another change was made in this adjustment. It was found that the focus often changed very perceptibly during a long exposure, and while the arrow-head image above described was suitable for guiding purposes, its form was not greatly affected by changes of focus. Between the crescent and the arrow-head images there is a transition form, in which two well-defined caustic curves in the aberration pattern intersect at an acute angle. The intersection of these caustics offers an excellent mark for the cross-wires, and is at the same time very sensitive to changes of focus, which cause it to travel up or down in the general pattern. The bed of the plate-holder was therefore raised, by facing it with a brass plate of the proper thickness.

Why the focus of the telescope should change during a long exposure is not quite clear. The change is much too great to be accounted for by expansion and contraction of the rods forming the tube, following changes of temperature, while a simple geometrical construction shows that a drooping of the upper end of the tube, increasing the distance of the plate from the (unreflected) axis of the mirror, can not displace the focus in a direction normal to the plate, if it is assumed that the field is flat. The observed effect is probably due to the fact that the focal surface is not flat, but curved. During a long exposure, the observer keeps the guiding star, and therefore, very approximately, all other stars, in the same positions relatively to the plate; but he has no control over the position of the axis of the mirror, which, by changes of flexure, wanders irregularly over the field. The position of maximum curvature, therefore, also varies, and with it the focus of the guiding star relatively to the cross-wires, where the focal surface is considerably inclined to the field of view. It is certain that the focus does change considerably, whatever the cause may be, and that the best photographic star images are obtained by keeping the focus of the guiding star unchanged during the exposures. This is done by turning the focusing screw of the eye-end.

In making the photographs of nebulæ for which the Crossley telescope is at present regularly employed, it was at first our practice to adjust the driving-clock as accurately as possible to a sidereal rate, and then, when the star had drifted too far from its original position, on account of changes of rate or of flexure, to bring it back by the right-ascension slow motion, the observer either closing the slide of the plate-holder or following the motion of the star as best he could with the right-ascension screw. Lately a more satisfactory method, suggested by Mr. Palmer, has been employed. The slow motion in right ascension is of Grubb's form,[1] and the telescope has two slightly different rates, according to whether the loose wheel is stopped or allowed to turn freely. The driving-clock is adjusted so that one of these rates is too fast, the other too slow. At the beginning of an exposure the wheel is, say, unclamped, and the guiding star begins to drift very slowly toward the left, the observer following it with the screw of the plate-holder. When it has drifted far enough, as indicated by the pins mentioned farther above, the wheel is clamped. The star then reverses its motion and begins to drift toward the right; and so on throughout the exposure. The advantages of this method over the one previously employed are, that the star never has to be moved by the slow motion of the telescope, and that its general drift is in a known direction, so that its movements can be anticipated by the observer. In this way photographs are obtained, with four hours' exposure, on which the smallest star disks are almost perfectly round near the center of the plate, and from 2″ to 3″ in diameter.

The star images are practically round over a field at least 1 inch or 16′ in diameter. Farther from the center they become parabolic, but they are quite good over the entire plate, 3¼ by 4¼ inches.

From these statements it will be seen that small irregularities in driving no longer present any difficulties. But certain irregular motions of the image still take place occasionally, and so far it has not been possible entirely to prevent their occurrence.

It was found that the declination clamp (the long slow-motion handle attached to which is shown in the illustration) was not sufficiently powerful to hold the telescope firmly during a long exposure. A screw clamp was therefore added, which

[1] *Mon. Not. R. A. S.*, **48**, 352.

forces the toothed-declination sector strongly against an iron block just behind it, thus restoring, I think, the original arrangement of the declination clamp as designed by Dr. Common. This clamp holds the tube very firmly.

The irregularities to which I have referred consist in sudden and unexpected jumps of the image, which always occur some time after the telescope has passed the meridian. These jumps are sometimes quite large—as much as one-sixteenth of an inch or 1 . They are due to two causes: flexure of the tube, and sliding of the mirror on its bed. When the jump is due to sudden changes of flexure, the image moves very quickly, and vibrates before it comes to rest in its new position, and at the same time there is often heard a slight ringing sound from the tension rods of the tube. There seems to be no remedy for the sudden motions of this class. The tension rods are set up as tightly as possible without endangering the threads at their ends or buckling the large corner tubes. A round telescope tube, made of spirally-wound steel ribbon riveted at the crossings, would probably be better than the square tube now in use.

Jumps due to shifting of the mirror are characterized by a gentle, gliding motion. They can be remedied, in part, at least, by tightening the copper bands which pass around the circumference of the mirror within its cell. This will be done the next time the mirror is resilvered.

All that the observer can do when a jump occurs is to bring back the image as quickly as possible to the intersection of the cross-wires. If all the stars on the plate are faint, no effect will be produced on the photograph; but stars of the eighth magnitude or brighter will leave short trails. The nebula, if there is one on the plate, will, of course, be unaffected.

Before beginning an exposure the focus is adjusted by means of a high-power positive eyepiece. An old negative, from which the film has been partially scraped, is placed in one of the plate-holders, and the film is brought into the common focus of the eyepiece and the great mirror. The appearance of the guiding star, which varies somewhat with the position of the guiding eyepiece on its slide, is then carefully noted, and is kept constant during the exposure by turning, when necessary, the focusing screw of the eye-end. For preliminary adjustments a ground-glass screen is often convenient. On it all the *DM.* stars, and even considerably fainter ones, as well as the nebulæ of Herschel's Class I, are easily visible without a lens.

Plates are backed, not more than a day or two before use, with Carbutt's "Columbian backing," which is an excellent preparation for this purpose. During the exposure the observer and assistant exchange places every half hour, thereby greatly relieving the tediousness of the work, though two exposures of four hours each, in one night, have proved to be too fatiguing for general practice. At the end of the first two hours it is necessary to close the slide and wind the clock.

The brightness of the guiding star is a matter of some importance. If the star is too bright, its glare is annoying; if it is too faint, the effort to see it strains the eye, and changes of focus are not easily recognized. A star of the ninth magnitude is about right. In most cases a suitable star can be found without difficulty.

In such an apparatus as that described above, the amount by which the plate may be allowed to depart from its zero position is subject to a limitation which has not, I think, been pointed out, although it is sufficiently obvious when one's attention has been called to it. It depends upon the fact that the plate necessarily moves as a whole, in a straight line which is tangent to a great circle of the sphere, while the stars move on small circles around the pole. The compensation for drift, when the plate is moved, is therefore exact at the equator only.

Let the guiding star have the declination δ_1, and let a star on the upper edge of the plate (which, when the telescope is north of the zenith, and the eye-end is on the north side of the telescope, will be the southern edge) have the declination δ_2. Then if the guiding star is allowed to drift from its zero position through the distance d, the other star will drift through the distance $d \frac{\cos \delta_2}{\cos \delta_1}$. If the guiding star is followed by turning the right-ascension screw, the upper edge of the plate, as well as the guiding eyepiece, will be moved through the distance d. Hence there will be produced an elongation of the upper star, represented by

$$e = d \left(\frac{\cos \delta_2}{\cos \delta_1} - 1 \right)$$

$$\text{from which } d = \frac{e \cos \delta_1}{\cos \delta_2 - \cos \delta_1} .$$

Now, in the Crossley reflector, the upper edge of the plate and the guiding eyepiece are just about 3⅔ inches, or 1°, apart. If e is given, the above formula serves to determine the maximum range of the slide for different positions of the telescope.

It has been stated farther above that the smallest star disks, on a good photograph, are sometimes not more than 2″ in diameter, or in a linear measure, about $\frac{1}{20}$ mm. An elongation of this amount is therefore perceptible. There are many nebulæ in high northern declinations, and there are several particularly fine ones in about +70°. If, therefore, we take $\delta_2 = 70°$, $\delta_1 = 71°$, $e = 0.05$, and substitute these values, we find $d = 1.0$ mm, which is the greatest permissible range of the plate in photographing these nebulæ. Before I realized the stringency of this requirement, by making the above simple computation, I spoiled several otherwise fine negatives by allowing the plate to get too far from the center, thus producing elongated star images.

There is a corresponding elongation in declination, the amount of which can be determined by an adaptation of the formula for reduction to the meridian, but it is practically insensible.

On account of the short focal length of the three-foot mirror, the photographic resolving power of the telescope is much below its optical resolving power. For this reason the photographic images are less sensitive to conditions affecting the seeing than the visual images. On the finest nights the delicate tracery of bright lines or caustic curves in the guiding star is as clear and distinct as in a printed pattern. When the seeing is only fair these delicate details are lost, and only the general form of the image, with its two principal caustics, is seen. A photograph taken on such a night is not, however, perceptibly inferior to one taken when the seeing is perfect. When, however, the image is so blurred that its general form is barely distinguishable, the photographic star disks are likewise blurred and enlarged, and on such nights photographic work is not attempted.

The foregoing account of the small changes which have been made in the Crossley telescope and its accessories may appear to be unnecessarily detailed, yet these small changes have greatly increased the practical efficiency of the instrument, and, therefore, small as they are, they are important. Particularly with an instrument of this character, the difference between poor and good results lies in the observance of just such small details as I have described.

At present the Crossley reflector is being used for photographing nebulæ, for which purpose it is very effective. Some nebulæ and clusters, like the great nebula in *Andromeda* and the *Pleiades*, are too large for its plate ($3\frac{1}{4} \times 4\frac{1}{4}$ in.), but the great majority of nebulæ are very much smaller, having a length of only a few minutes of arc, and a large-scale photograph is required to show them satisfactorily. It is particularly important to have the images of the involved stars as small as they can be made.

Many nebulæ of Herschel's I and II classes are so bright that fairly good photographs can be obtained with exposures of from one to two hours; but the results obtained with full-light action are so superior to these, that longer exposures of three and one half or four hours are always preferred. In some exceptional cases, exposures of only a few minutes are sufficient. The amount of detail shown, even in the case of very small nebulæ, is surprising. It is an interesting fact that these photographs confirm (in some cases for the first time) many of the visual observations made with the six-foot reflector of the Earl of Rosse.

Incidentally, in making these photographs, great numbers of new nebulæ have been discovered. The largest number that I have found on any one plate is thirty-one. Eight or ten is not an uncommon number, and few photographs have been obtained which do not reveal the existence of three or four. A catalogue of these new objects will be published in due time.

Some of the results obtained with the Crossley reflector, relating chiefly to particular objects of some special interest, have already been published.[1] The photographs have also permitted some wider conclusions to be drawn, which are constantly receiving further confirmation as the work progresses. They may be briefly summarized as follows:

1. Many thousands of unrecorded nebulæ exist in the sky. A conservative estimate places the number within reach of the Crossley reflector at about 120,000. The number of nebulæ in our catalogues is but a small fraction of this.

2. These nebulæ exhibit all gradations of apparent size, from the great nebula in *Andromeda* down to an object which is hardly distinguishable from a faint star disk.

3. Most of these nebulæ have a spiral structure.

To these conclusions I may add another, of more restricted significance, though the evidence in favor of it is not yet complete. Among the objects which have been photographed with the Crossley telescope are most of the "double" nebulæ figured in Sir John Herschel's catalogue (*Phil. Trans.*, 1833, Plate XV). The actual nebulæ, as photographed, have almost no resemblance to the figures. They are, in fact, spirals, sometimes of very beautiful and complex structure; and, in any one of the nebulæ, the secondary nucleus of Herschel's figure is either a part of the spiral approaching the main nucleus in brightness, or it can not be identified with any real part of the object. The significance of this somewhat destructive conclusion lies in the fact that these figures of Herschel have sometimes been regarded as furnishing analogies for the figures which Poincaré had deduced, from theoretical considerations, as being among the possible forms assumed by a rotating fluid mass; in other words, they have been regarded as illustrating an early stage in the development of double star systems. The actual conditions of motion in these particular nebulæ, as indicated by the photographs, are obviously very much more complicated than those considered in the theoretical discussion.

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[1] The following list includes all papers of interest:

"Photographic Observations of Comet I, 1898 (Brooks), made with the Crossley Reflector of the Lick Observatory." A. J. No. 451, **19**, 151; see also *Ap. J.*, **8**, 287.

"The Small Bright Nebula near *Merope*," *Pub. A. S. P.*, **10**, 245.

"On Some Photographs of the Great Nebula in *Orion*, taken by means of the Less Refrangible Rays in its Spectrum," *Ap. J.*, **9**, 133. See also *Pub. A. S. P.*, **11**, 70; *Ap. J.*, **10**, 167; *A. N.*, 3601.

"Small Nebulæ discovered with the Crossley Reflector of the Lick Observatory," *Mon. Not. R. A. S.*, **59**, 537.

"The Ring Nebula in *Lyra*," *Ap. J.*, **10**, 193.

"The Annular Nebula H. IV. 13 in *Cygnus*," *Ap. J.*, **10**, 266; see also *Pub. A. S. P.*, **11**, 177.

"On the Predominance of Spiral Forms among the Nebulæ," *A. N.*, 3601.

"The Distribution of Stars in the Cluster *Messier* 13 in *Hercules*" (by H. K. Palmer), *Ap. J.*, **10**, 246.

"The Photographic Efficiency of the Crossley Reflector," *Pub. A. S. P.*, **11**, 199; *Observatory*, **22**, 437.

"New Nebulæ discovered photographically with the Crossley Reflector of the Lick Observatory," *Mon. Not. R. A. S.*, **60**, 128.

"The Spiral Nebula, H. I., 55 *Pegasi*," *Ap. J.*, **11**, 1.

"Photographic Observations of Hind's Variable Nebula in *Taurus*, made with the Crossley Reflector of the Lick Observatory," *Mon. Not. R. A. S.*, **60**, 424.

"Use of the Crossley Reflector for Photographic Measurements of Position," *Pub. A. S. P.*, **12**, 73.

"Discovery and Photographic Observations of a New Asteroid 1899 FD.," *A. N.*, 3635.

"Elements of Asteroid 1899 FD." (by H. K. Palmer), *A. N.* 3635.

While I must leave to others an estimate of the importance of these conclusions, it seems to me that they have a very direct bearing on many, if not all, questions concerning the cosmogony. If, for example, the spiral is the form normally assumed by a contracting nebulous mass, the idea at once suggests itself that the solar system has been evolved from a spiral nebula, while the photographs show that the spiral nebula is not, as a rule, characterized by the simplicity attributed to the contracting mass in the nebular hypothesis. This is a question which has already been taken up by Professor Chamberlin and Mr. Moulton of the University of Chicago.

The Crossley reflector promises to be useful in a number of fields which are fairly well defined. It is clearly unsuitable for photographing the Moon and planets, and for star charting. On the other hand, it has proved to be of value for finding and photographically observing asteroids whose positions are already approximately known.

One of the most fruitful fields for this instrument is undoubtedly stellar spectroscopy. Little has been done in this field, as yet, with the Crossley reflector, but two spectrographs, with which systematic investigations will be made, have nearly been completed by the Observatory instrument-maker. One of these, constructed with the aid of a fund given by the late Miss C. W. Bruce, has a train of three 60° prisms and one 30° prism, and an aperture of two inches; the other, which has a single quartz prism, will, I have reason to expect, give measurable, though small, spectra of stars nearly at the limit of vision of the telescope.

The photogravure* of the Trifid nebula, which accompanies this article, was made from a photograph taken with the Crossley reflector on July 6, 1899, with an exposure of three hours. It was not selected as a specimen of the work of the instrument, for the negative was made in the early stages of the experiments that I have described, and the star images are not good, but rather on account of the interest of the subject. At the time the photogravures were ordered no large scale photograph of the Trifid nebula had, so far as I am aware, ever been published.[1] The remarkable branching structure of the nebula is fairly well shown in the photogravure, though less distinctly than in the transparency from which it was made. The enlargement, as compared with the original negative, is 2.9 diameters (1 mm = 13″). The fainter parts of the nebula would be shown more satisfactorily by a longer exposure.

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*Footnote added in 1908: This concluding paragraph, retained in the present publication for completeness, loses point in some particulars, because the photogravure referred to is not reproduced here. The heliogravure reproduction of the Trifid nebula is No. 55.

[1] Since then a photograph by Dr. Roberts has appeared in *Knowledge*, **23**, 35, February, 1900.

List of Nebulæ and Clusters Photographed.

N.G.C. No.	α 1900.0 h	m	s	δ 1900.0 °	′	Remarks.
185	0	33	25	+47	47.3	H II, 707
205	0	34	56	+41	8.2	H V, 18
221	0	37	15	+40	19.0	M 32
224	0	37	17	+40	43.4	Great nebula in *Andromeda*
247	0	42	3	−21	17.9	H V, 20
253	0	42	36	−25	50.6	H V, 1
524	1	19	33	+9	1.0	H I, 151
598	1	28	12	+30	8.6	M 33
628	1	31	19	+15	16	M 74
650	1	36	0	+51	4.0	M 76
891	2	16	15	+41	53.6	H V, 19
1023	2	34	8	+38	38.0	H I, 156
1068	2	37	34	−0	26.3	M 77
1084	2	41	5	−8	0.0	H I, 64
. . .	3	41		+24		*Pleiades* in *Taurus*
1555	4	16	8	+19	17	T *Tauri* and Hind's variable nebula
1931	5	24	48	+34	10.1	H I, 261
1952	5	28	30	+21	57	Crab nebula in *Taurus*
. . .	5	30		−5		Great nebula in *Orion*
1977	5	30	27	−4	54.2	H V, 30
2024	5	36	48	−1	54.3	H V, 28
2068	5	41	37	+0	0.8	M 78
2239	6	25	37	+5	1.1	Cluster and nebula in *Monoceros*
2264	6	35		+10	0	Nebula near 15 *Monocerotis*
2287	6	42	43	−20	38.4	M 14
. . .	6	59	40	−10	18.2	New nebula in *Monoceros*
2359	7	12	54	−13	2.0	H V, 21
2366	7	18	18	+69	13.4	H III, 748
2371–2	7	19	6	+29	41.0	H II, 316–7
2403	7	27	9	+65	48.9	H V, 44
2437	7	35	24	−14	35.3	Cluster and nebula M 46
2632	8	34		+20		*Præsepe* cluster
2683	8	46	29	+33	47.8	H I, 200
2841	9	15	6	+51	24	H I, 205
2903–05	9	26	31	+21	57	H I, 56–57
3003	9	42	38	+33	52.8	H V, 26
3031	9	47	18	+69	32	M 81
3079	9	55	9	+56	10.1	H V, 47
3115	10	0	16	−7	14.0	H I, 163
3169	10	9	4	+3	57.7	H I, 4
3184	10	12	15	+41	55.1	H I, 168
3198	10	13	42	+46	3.7	H I, 199
3226–7	10	17	59	+20	24.1	H II, 28–29
3242	10	19	29	−18	5	H IV, 27
. . .	10	21	7	+68	58	New nebula in *Ursa Major* (Coddington).
3556	11	5	40	+56	13.0	H V, 46
3587	11	9	0	+55	33.7	Owl nebula, M 97
3623	11	13	43	+13	38.4	M 65

N. G. C. No.	α 1900.0 h	m	s	δ 1900.0 °	′	Remarks.
3627	11	15	1	+13	32	M 66
3726	11	27	56	+47	35.8	H II, 730
4244	12	12	29	+38	22.0	H V, 41
4254	12	13	45	+14	59	M 99
4258	12	14	2	+47	51.6	H V, 43
4303	12	16	18	+5	1.7	M 61
4321	12	17	52	+16	22.7	M 100
4382	12	20	21	+18	44.7	M 85
4485–90	12	25	40	+42	15.3	H I, 197–198
4501	12	26	56	+14	58.5	M 88
4536	12	29	20	+2	44.2	H V, 2
4559	12	30	59	+28	30.6	H I, 92
4565	12	31	24	+26	32.2	H V, 24
4631	12	37	19	+33	5.9	H V, 42
4656–57	12	39	6	+32	42.8	H I, 176–7
4725	12	45	33	+26	3	H I, 84
4736	12	46	13	+41	39.5	M 94
4826	12	51	49	+22	13.9	M 64
5055	13	11	20	+42	33.6	M 63
5194–5	13	25	39	+47	42.6	M 51
5247	13	32	39	−17	22.4	H II, 297
5272	13	37	35	+28	53	M 3
5457–8	13	59	39	+54	50	M 101
5857–9	15	2	55	+19	58.9	H II, 751–2
5866	15	3	45	+56	9.0	H I, 215
5904	15	13	29	+2	27	M 5
6205	16	38	6	+36	39.0	M 13
6218	16	42	2	−1	46.2	M 12
6412	17	32	41	+75	47.3	H VI, 41
6514	17	55	43	−23	2	Trifid nebula in *Sagittarius*
6523	17	57	43	−24	23	M 8
6543	17	58	35	+66	38	H IV, 37
6618	18	15	0	−16	13	M 17 Omega nebula
6656	18	30	17	−23	59.3	M 22
6705	18	45	42	−6	23.3	M 11
6720	18	49	53	+32	54.0	M 57
6853	19	55	17	+22	27	Dumb-Bell nebula
6894	20	12	22	+30	15.5	H IV, 13
6946	20	32	48	+59	48.0	H IV, 76
6951	20	35	47	+65	45.4	
6995	20	53	0	+30	49.8	
7008	20	57	38	+54	9.5	H I, 192
7009	20	58	11	−11	48	H IV, 1
7023	21	0	30	+67	46.2	H IV, 74
7078	21	25	9	+11	43.7	M 15
7089	21	28	19	−1	16.0	M 2
7099	21	34	42	−23	38.0	M 30
7217	22	3	24	+30	52.3	H II, 207
7331	22	32	30	+33	53.9	H I, 53
7448	22	55	7	+15	26.6	H II, 251
7479	22	59	56	+11	47.0	H I, 55
7537–41	23	9	38	+3	59.4	H II, 429–30
7662	23	21	5	+41	59.2	H IV, 18
7782	23	48	47	+7	24.8	H III, 233
7814	23	58	8	+15	34.5	H II, 240
7817	23	58	52	+20	11.6	H II, 227

CATALOGUE OF NEW NEBULÆ DISCOVERED ON THE NEGATIVES.

No.	α 1900.0	Precession.	δ 1900.0	Precession.	Description.
	h m s	s	° ′ ″	″	
1	0 0 27.4	+3.0732	+20 34 57	+20.048	vS eeF
2	0 32 7.7	3.2795	+47 55 29	19.855	eF N
3	0 32 8.1	3.2801	+48 1 22	19.855	F vbM E140°
4	0 32 9.3	3.2776	+47 37 24	19.855	eF bM
5	0 32 28.8	3.2799	+47 39 5	19 851	B vE70°
6	0 33 23.9	3.2674	+47 55 5	19.841	eF vS
7	0 35 43.1	3.3009	+47 46 18	19.810	eF vS
8	0 40 51.1	2.9793	−21 25 48	19.730	18 vS R
9	0 41 0.1	2.9804	−21 9 17	19.727	16 vS bM 3 sep. parts
10	0 41 16.2	2.9781	−21 29 43	19.723	18 vS R bM
11	0 41 16.7	2.9792	−21 15 2	19.723	18 vS R
12	0 41 29.7	2.9798	−21 3 8	19.719	18 vS bM E50°
13	0 42 4 4	2.9633	−26 0 7	19.711	17 vS R bsw
14	0 42 30.7	2.9780	−20 56 38	19.703	18 vS bM E115°
15	0 42 34.2	2.9620	−25 59 10	19.702	17 vS N E160°
16	0 42 37.6	2.9776	−20 58 28	19.701	14 S E stell N
17	0 42 39.7	2.9772	−21 1 54	19.701	17 vS Spiral bM
18	0 42 39.9	2.9774	−21 0 3	19.700	18 vS Ring?
19	0 42 40.5	2.9770	−21 3 55	19.700	15 S Spiral N bM
20	0 42 40 6	2.9762	−21 13 54	19.700	18 vS R
21	0 43 10.4	2.9603	−25 59 36	19.692	18 vS R bM
22	0 43 16.2	2.9730	−21 37 17	19.691	18 vS dif
23	0 43 27.1	2.9613	−25 40 21	19.688	17 vS R N
24	0 43 29.0	2.9593	−26 0 57	19.687	18 vS R gbM
25	0 44 10.8	2.9714	−21 30 29	19.676	18 vS R
26	0 44 26.6	2.9735	−20 58 35	19.672	17 vS R bM
27	1 18 30.9	3.1475	+ 9 27 25	18.887	F S N
28	1 18 53.5	3.1475	+ 9 24 28	18.875	F vbM Spiral?
29	1 19 11.3	3.1474	+ 9 21 53	18.867	F vbM Spiral?
30	1 19 30.7	3.1467	+ 9 14 18	18.857	F bM E
31	1 29 50.7	3.2101	+15 6 37	18.526	pF E45° bp
32	1 29 54.4	3.2161	+15 43 25	18.524	F R
33	1 30 20.9	3.2127	+15 17 38	18.509	vF L R
34	1 30 24.7	3.2132	+15 20 28	18.507	pF S vF extension 135°
35	1 30 35.9	3.2153	+15 32 2	18.501	S pB pmb M
36	1 30 54.7	3.2176	+15 43 1	18.491	vvF vS
37	1 31 5.0	3.2179	+15 43 38	18.485	F S E95°
38	1 31 15.9	3.2159	+15 30 44	18.478	pF S R
39	1 31 25.7	3.2187	+15 44 34	18.473	vF S R
40	1 31 44.8	3.2194	+15 46 49	18.462	F L R gbM
41	1 31 44.8	3.2126	+15 4 18	18.462	F L gbM R
42	1 32 5.9	3.2158	+15 20 54	18.450	S pB E135°
43	1 32 41.3	3.2171	+15 23 22	18.430	vF S E45°
44	1 32 48.8	3.2156	+15 12 27	18.424	vF pL
45	1 33 10.4	3.2168	+15 16 49	18 413	vF pL gbM
46	1 33 13.2	3.2166	+15 15 14	18.412	p B R gbM
47	2 14 10.2	3.7341	+41 50 8	16.715	pF E135°
48	2 14 26.6	3.7349	+41 49 1	16.701	pB N R
49	2 14 33.9	3.7307	+41 37 31	16.696	B N
50	2 14 36.7	3.7313	+41 38 24	16.694	F
51	2 14 55.0	3.7506	+42 24 20	16.677	eF vS bM E135°
52	2 15 6.2	3.7517	+42 25 6	16.668	F gbM E130° Spiral?
53	2 15 14.9	3.7493	+42 16 44	16.661	F pmbM
54	2 15 16.1	3.7484	+42 14 4	16.659	F B*f
55	2 15 38.4	3.7666	+42 55 0	16.641	eF vS R
56	2 15 43.8	3.7503	+42 13 58	16.637	S F R
57	2 15 56.5	3.7724	+43 5 24	16.626	F E170° bsf
58	2 16 1.0	3.7539	+42 20 55	16.623	B S vbM E150° bnp
59	2 16 6.4	3.7403	+41 44 51	16.619	S F R
60	2 16 9.7	3.7408	+41 45 26	16.616	F S pmbM
61	2 16 13.0	3.7613	+42 36 32	16.613	pB vbM E150° Spiral?
62	2 16 31.1	3.7640	+42 39 27	16.598	eeF E50°
63	2 16 34.5	3.7412	+41 42 6	16.595	pB pmbM
64	2 16 40.3	3.7620	+42 33 22	16.591	B S pbM
65	2 16 43.3	3.7403	+41 38 14	16.588	pB E0° pmbM
66	2 16 53.2	3.7625	+42 32 12	16.580	vB S mbM
67	2 16 57.8	3.7567	+42 16 48	16.576	F triN npN
68	2 17 13.8	+3.7403	+42 22 37	+16.563	pB bs B*p

No.	α 1900.0			Precession.	δ 1900.0			Precession.	Description.
	h	m	s	s	°	′	″	″	
69	2	17	18.9	+3.7661	+42	36	12	+16.559	pS pB gbM E40°
70	2	17	28.5	3.7415	+41	33	3	16.551	pF S R
71	2	17	28.8	3.7560	+42	9	35	16.551	vF
72	2	17	33.2	3.7606	+42	20	17	16.547	F vS bnp
73	2	17	36.2	3.7789	+43	3	25	16.545	eeF S
74	2	17	37.2	3.7469	+41	45	2	16.544	F vL vmbM
75	2	17	41.8	3.7592	+42	15	8	16.540	S pB bs
76	2	17	43.3	3.7554	+42	5	21	16.539	F bsp
77	2	17	44.6	3.7441	+42	18	28	16.538	B S E90° bM
78	2	17	45.5	3.7425	+42	22	45	16.537	F L bM N B*np
79	2	17	50.8	3.7743	+42	50	20	16.533	pB gbM E135°
80	2	17	51.1	3.7484	+41	46	22	16.532	pB E135° gbM
81	2	18	0.2	3.7743	+42	48	30	16.525	vF pL gbM E50°
82	2	18	0.8	3.7502	+41	48	55	16.525	pF L
83	2	18	4.2	3.7603	+42	14	0	16.522	S B vbM
84	2	18	14.8	3.7579	+42	7	27	16.513	pB E150° Spiral
85	2	18	23.6	3.7792	+42	56	10	16.507	eeF pL E120°
86	2	18	26.7	3.7604	+42	10	8	16.503	vB E45°
87	2	18	30.7	3.7465	+41	34	13	16.499	F E150° bnf
88	2	18	33.5	3.7784	+42	52	19	16.498	B S gbM
89	2	18	34.0	3.7628	+42	14	44	16.497	vS vF bsp
90	2	18	37.4	3.7837	+43	4	26	16.495	S F bs
91	2	31	51.3	3.7209	+38	16	30	15.806	vF vS
92	2	33	53.9	3.7295	+38	19	27	15.694	F vS N
93	2	33	56.7	3.7461	+38	49	15	15.691	F S bn E0° long N
94	2	34	7.5	3.7405	+38	43	4	15.681	pF S i triN
95	2	34	9.2	3.7399	+38	43	10	15.680	pF vS
96	2	34	11.8	3.7259	+38	7	39	15.678	F L E40° Spiral on edge.
97	2	34	44.2	3.7402	+38	38	27	15.648	eeeF doubtful
98	2	34	44.4	3.7488	+38	16	16	15.648	pB N E50° S pmbM
99	2	35	1.0	3.7469	+38	18	45	15.632	L F pmbM
100	2	36	32.9	3.7436	+38	30	26	15.548	S F E100°
101	2	36	53.3	3.0662	− 0	24	48	15.525	vS vF gbM
102	2	37	6.0	3.0728	− 0	2	43	15.518	vS F mE30°
103	2	38	44.2	3.0688	− 0	16	20	15.427	F S mE80°
104	2	41	11.6	2.9503	− 8	3	17	15.294	pB vS E135°
105	2	41	53.7	2.9564	− 7	38	9	15.254	vF vS mbM
106	2	42	18.9	2.9499	− 8	2	27	15.230	eeF S
107	4	35	22.9	3.0244	− 2	12	20	7.235	16 S E165° Dif bM
108	4	36	0.6	3.0307	− 1	54	37	7.183	18 vS R
109	4	36	3.6	3.0300	− 1	56	42	7.179	17 vS R stell
110	4	36	12.7	3.0337	− 1	46	19	7.167	16 vs nearly R bM
111	4	36	15.2	3.0238	− 2	13	38	7.164	18 vS R (Spiral ?)
112	4	36	40.5	3.0251	− 2	9	53	7.129	18 vS R N
113	4	36	41.2	3.0293	− 1	58	23	7.128	18 vS E30° bn
114	4	37	2.4	3.0268	− 2	5	10	7.099	18 vS dif
115	4	37	26.8	3.0298	− 1	56	51	7.066	15 vS Spiral B N (stell)
116	5	24	48.1	3.9674	+34	6	28	+ 3.075	bright stell N on north side
117	7	14	0.7	6.4903	+69	39	20	− 6.362	17 vS bM
118	7	14	24.5	6.4656	+69	31	49	6.395	17 vS N Ring
119	7	14	37.5	6.4241	+69	18	15	6.413	17 R bM
120	7	15	45.6	6.4282	+69	21	35	6.507	17 vS
121	7	15	50.7	6.4875	+69	41	26	6.514	16 vS R
122	7	16	4.1	6.4719	+69	36	40	6.532	17 vS E125° D ?
123	7	16	8.0	6.4219	+69	20	4	6.538	18 vS E70°
124	7	16	35.2	6.4099	+69	16	46	6.575	16 vS iF
125	7	16	48.0	6.4578	+69	33	16	6.593	17 vS R
126	7	17	9.1	6.4119	+69	18	25	6.622	18 vS R
127	7	17	38.5	6.4906	+69	45	29	6.662	17 vS bM R
128	7	17	45.3	6.4750	+69	40	36	6.672	17 vS R bM
129	7	17	49.6	3.7911	+29	41	49	6.677	18 vS F*inv dif
130	7	17	49.7	6.4843	+69	43	46	6.678	17 vS E135° bM N Spiral
131	7	18	11.1	6.4754	+69	41	28	6.707	16 vS dif 2 or 3 N
132	7	18	14.4	3.7838	+29	27	41	6.711	18 vS iF N
133	7	18	20.1	3.7840	+29	28	20	6.719	18 vS bM
134	7	18	21.1	3.7950	+29	51	18	6.721	18 vS bM
135	7	18	42.2	3.7832	+29	27	23	6.749	18 vS iF sc
136	7	18	51.0	6.6430	+69	38	32	6.763	17 vS E80° bM N Spiral on edge
137	7	18	56.5	3.7827	+29	27	7	6.769	19 vS
138	7	19	10.0	+3.7819	+29	26	7	−6.788	18 vS R bM N Spiral ?

No.	α 1900.0			Precession.	δ 1900.0			Precession.	Description.
	h	m	s	s	°	′	″	″	
139	7	19	11.6	+3.7800	+29	22	12	− 6.790	18 vS bM
140	7	19	11.8	6.4683	+69	40	54	6.790	15 vS Neb$_*$
141	7	19	25.2	6.4609	+69	38	50	6.809	16 vS R bM N Spiral?
142	7	19	30.0	3.7874	+29	38	22	6.816	18 vS 2N R
143	7	19	34.0	6.4629	+69	39	46	6.821	17 vS R
144	7	19	46.5	3.7859	+29	35	58	6.839	18 vS bM N R
145	7	19	48.3	3.7866	+29	37	21	6.841	18 vS R bM
146	7	21	13.4	6.4694	+69	44	51	6.957	17 vS R bM N Spiral?
147	7	21	57.9	6.4648	+69	44	42	7.018	17 vS bM N R Spiral?
148	7	24	8.0	5.8308	+65	39	28	7.198	pB E200° bn
149	7	30	37.2	5.8297	+65	53	16	7.720	vF vS
150	7	31	10.9	5.8139	+65	47	0	7.767	pB S gpmbM
151	8	32	38.8	3.4536	+19	56	37	12.387	16 S E10° stell N M (Spiral on edge?)
152	8	32	40.2	3.4534	+19	56	0	12.388	17 E95° S dif
153	8	34	11.6	3.4527	+19	59	50	12.493	17 vS E30° stell N Spiral?
154	8	35	28.9	3.4520	+20	2	47	12.581	17 S Spiral N
155	8	36	7.4	3.4514	+20	3	33	12.624	17 S R bM N
156	8	44	40.5	3.7549	+34	13	21	13.203	eF E140°
157	8	46	1.9	3.7442	+33	50	57	13.290	vF vS
158	8	46	26.8	3.7403	+33	44	26	13.318	F vS N E120° Spiral
159	8	46	52.6	3.7397	+33	45	19	13.345	pB eS N R
160	8	47	20.6	3.7507	+34	14	43	13.376	eF eS bf
161	8	47	56.9	3.7509	+34	18	41	13.415	eeF
162	9	12	0.0	4.2083	+51	47	20	14.898	L 12 mE135°
163	9	12	2.1	4.2062	+51	44	32	14.904	16 E80° bs S
164	9	12	12.5	4.2001	+51	36	54	14.910	17 vS Ring bs
165	9	12	38.0	4.1950	+51	31	43	14.939	16 E155° gbm
166	9	12	40.4	4.1862	+51	18	0	14.936	16 vS E15° stell N
167	9	12	45.4	4.1835	+51	16	34	14.942	16 E75° vbN Spiral?
168	9	13	54.3	4.1814	+51	22	45	15.009	18 vS N bM
169	9	14	0.5	4.1839	+51	26	53	15.016	18 vS scNuclei
170	9	15	23.9	4.1662	+51	11	46	15.091	17 vS R
171	9	15	24.6	4.1652	+51	10	12	15.091	17 vS bN Ring or Spiral
172	9	15	29.3	4.1658	+51	11	59	15.096	17 S R
173	9	15	44.6	4.1631	+51	11	26	15.111	15 B bM E145°
174	9	16	6.3	4.1821	+51	42	11	15.136	17 R S
175	9	16	14.6	4.1638	+51	15	42	15.142	17 L vF bM
176	9	16	31.6	4.1528	+51	46	32	15.168	17 R S bs
177	9	24	20.2	3.4095	+21	49	50	15.597	vF vS
178	9	24	36.8	3.4084	+21	48	6	15.612	pB bs S
179	9	25	58.5	3.4047	+21	45	25	15.687	eF E85°
180	9	26	22.5	3.4046	+21	48	50	15.711	pB S R gpmbM N
181	9	28	0.2	3.4020	+21	52	36	15.801	eeF vS
182	9	41	3.6	3.5855	+33	58	24	16.474	16 vS bM E75°
183	9	41	9.9	3.5850	+33	58	12	16.480	15 vS sbM Spiral
184	9	42	9.0	3.5779	+33	45	49	16.528	17 vS N Spiral?
185	9	42	49.5	3.5822	+34	6	11	16.561	16 vS bM
186	9	43	12.4	3.5805	+34	4	43	16.580	15 vS sbM N Spiral
187	9	43	29.2	3.5789	+34	2	26	16.594	16 vS bnw R
188	9	44	13.0	3.5764	+34	2	7	16.630	14 vS bM N Spiral
189	9	44	24.6	3.5760	+34	3	1	16.640	16 vS R N Spiral?
190	9	44	44.4	3.5668	+33	37	27	16.656	17 vS E20°
191	9	44	52.8	5.0574	+69	28	13	16.670	pB vS R gpmbM
192	9	47	5.7	4.9895	+69	5	27	16.776	pF S bf E90°
193	9	47	22.2	4.9858	+69	5	25	16.790	vF dif
194	9	50	19.4	4.9915	+69	30	40	16.930	pF S E120°
195	9	50	52.8	4.9930	+69	35	26	16.955	eeF S E120°
196	9	50	59.1	5.0068	+69	44	0	16.959	pB S E50° pmbM Spiral
197	9	52	29.2	4.9219	+69	6	51	17.039	eF E100°
198	9	54	4.1	4.1109	+56	5	53	17.096	11 vS neb$_*$
199	9	54	24.7	4.1167	+56	18	38	17.111	18 vS R
200	9	54	26.5	4.1121	+56	11	53	17.113	15 vS E95° bM
201	9	55	14.0	4.1162	+56	27	13	17.148	17 vS R
202	9	56	46.2	4.0872	+56	0	18	17.219	17 vS R bM
203	9	57	29.5	4.0952	+56	20	33	17.250	15 vS R N
204	10	0	15.3	2.9839	− 7	33	34	17.372	17 vS sbN Spiral
205	10	0	40.4	2.9909	− 6	59	25	17.391	17 vS stell sbN
206	10	0	42.8	2.9850	− 7	29	50	17.392	11 S D iF gbN bn
207	10	1	49.7	2.9891	− 7	12	11	17.441	17 vS stell
208	10	6	50.1	+3.1101	+ 3	50	57	−17.653	14 vS D neb$_*$

No.	α 1900.0			Precession.	δ 1900.0			Precession.	Description.
	h	m	s	s	°	′	″	″	
209	10	7	18.1	+3.1112	+ 4	5	30	−17.671	16 vS iF bM
210	10	7	18.5	3.1112	+ 4	4	25	17.672	16 vS bM N Spiral E50°
211	10	7	58.4	3.1128	+ 3	58	44	17.699	16 vS sbM N Spiral E20°
212	10	8	20.6	3.1137	+ 3	52	13	17.714	15 S iF bM
213	10	9	40.7	3.1169	+ 4	8	34	17.769	18 vS R
214	10	9	44.8	3 1171	+ 4	9	47	17.772	17 vS sbM N Spiral ? E45°
215	10	9	48.3	3.6290	+42	0	20	17.776	16 E95° 33″ long small spur follows E45°
216	10	9	50.2	3.1172	+ 4	10	50	17.776	17 vS bM N R
217	10	9	58.9	3.6294	+42	4	6	17.783	17 vS R
218	10	10	3.0	3.6318	+42	12	15	17.786	17 vvS stell
219	10	10	15.5	3.6205	+41	39	52	17.793	15 S E60°
220	10	10	16.8	3.6317	+42	15	56	17.795	vS R stell
221	10	10	16.8	3.6311	+42	14	7	17.795	18 vvS sbN Spiral ?
222	10	10	21.8	3.1184	+ 3	51	52	17.797	17 vS bM N Spiral
223	10	10	23.0	3.6194	+41	38	24	17.798	16 vS bM Spiral N
224	10	10	23.9	3.6208	+41	42	47	17.799	18 vvS R Spiral ? N
225	10	10	24.5	3.6206	+41	42	41	17.800	18 vvS sbN iF
226	10	10	50.9	3.6230	+41	56	45	17.817	18 vvS iF
227	10	10	54.4	3.6245	+42	2	23	17.819	17 vS iF
228	10	11	44.0	3.6222	+42	7	31	17.852	18 vvS bn iF
229	10	11	44.0	3.6221	+42	7	3	17.852	18 vvS Spiral sbN
230	10	11	47.5	3 6210	+42	4	27	17.854	17 vS sbN Spiral
231	10	11	52.1	3.6945	+45	40	52	17.856	F S R gbM bf
232	10	11	52.2	3.6214	+42	6	56	17.857	18 vvS iF stell
233	10	12	6.2	3.6114	+41	36	50	17.861	10 S neb*
234	10	12	21.8	3.6231	+42	19	55	17.878	17 vS sbN Spiral
235	10	12	29.1	3.6192	+42	8	54	17.882	17 vS sbN Spiral
236	10	12	31.5	3.6204	+42	13	16	17.883	16 vS stell
237	10	12	33.4	3.6184	+42	7	46	17.884	18 vS E100° Spiral ?
238	10	12	41.5	3.6939	+45	51	34	17.890	eeeF ? ?
239	10	12	43.2	3.6150	+41	59	8	17.891	17 vS sbM N
240	10	12	43.5	3.6168	+42	5	16	17.891	16 vvS bN stell
241	10	12	48.1	3.6940	+45	53	41	17.894	F vS R gbM
242	10	12	50.6	3.6940	+45	54	11	17.896	F S E90°
243	10	12	51.3	3.6163	+42	5	23	17.897	18 vvS R stell
244	10	12	57.8	3.6136	+41	58	39	17.901	18 vvS iF
245	10	13	0.4	3.6212	+42	23	5	17.902	16 vS iB N Spiral E30°
246	10	13	4.1	3.6999	+46	14	17	17.905	B S E130° Spiral on edge
247	10	13	10.1	3.7010	+46	18	50	17.909	B R vm bM
248	10	13	19.7	3.6960	+46	7	15	17.915	eF S R bM
249	10	13	33.8	3.6170	+42	17	28	17.924	18 vS stell
250	10	13	37.1	3.6054	+41	42	39	17.927	17 vS Spiral stell N
251	10	13	44.2	3.6159	+42	16	17	17.929	17 vS R gbN
252	10	13	46.0	3.6110	+42	1	15	17.933	17 vvS gbN Spiral N
253	10	13	48.5	3.6972	+46	17	57	17.934	F S E170° Spiral ?
254	10	13	53.9	3.6036	+41	41	1	17.938	18 vS sbN
255	10	13	54.5	3.6107	+42	3	31	17.938	17 vS R gbN
256	10	13	57.9	3.6103	+42	3	5	17.940	17 vS iF gbN
257	10	14	0.0	3.6032	+41	41	9	17.942	18 vvS iF
258	10	14	5.5	3.6812	+45	37	1	17.944	vF vvS R
259	10	14	11.5	3.6113	+42	9	10	17.949	18 vvS bN Spiral
260	10	14	12.5	3.6113	+42	9	44	17.949	17 vS sbN Spiral
261	10	14	24.2	3.6104	−42	9	42	17.958	19 vvS iF E130°
262	10	14	26.8	3.6865	+45	57	27	17.958	B S E45°
263	10	14	33.0	3.6785	+45	36	39	27.962	vF vS E100°
264	10	14	35.7	3.6250	+42	0	31	17.965	17 vS Spiral N E100°
265	10	14	46.3	3.6916	+46	16	40	17.972	vvF E100° spindle shaped
266	10	14	52.3	3.6779	+45	39	59	17.975	vF S R
267	10	15	22.5	3.6866	+46	11	40	17.995	F R S gbM
268	10	16	17.4	3.6765	+45	57	9	18.031	F S R gbM
269	10	16	27.1	4.5844	+68	53	10	18.038	S pB bf
270	10	16	37.1	3.6761	+46	1	1	18.044	F pmbM E10°
271	10	17	8.0	3.2872	+20	19	46	18.062	13 vS sbM N Spiral E135°
272	10	17	12.7	3.2868	+20	18	16	18.065	13 vS gbM Spiral
273	10	17	19.6	3.2865	+20	17	47	18.070	14 vS gbN
274	10	17	47.1	3.2899	+20	40	58	18.087	15 vS iF gbM
275	10	17	53.6	3.2880	+20	31	57	18.091	14 S sbM N Spiral E130°
276	10	18	7.1	3.2906	+20	47	25	18.100	13 vS sbM N Spiral
277	10	19	5.2	3.2870	+20	38	42	18.136	13 S sbM N Spiral
278	10	19	6.9	+3.2857	+20	32	21	−18.137	16 vS iF gbM

No.	α 1900.0	Precession.	δ 1900.0	Precession.	Description.
	h m s	s	° ′ ″	″	
279	10 19 10.3	+3.2885	+20 47 38	−18.139	14 vS stell
280	10 19 20.6	4.5635	+69 9 51	18.149	S pF R
281	10 24 6.2	4.4863	+68 59 31	18.317	vS F E95°
282	11 1 52.7	3.5701	+55 59 0	19.407	16 vS bN iF
283	11 2 5.8	3.5753	+56 25 16	19.412	15 vS neb*
284	11 2 9.5	3.5660	+55 53 31	19.413	16 S gbM E100°
285	11 2 22.6	3.5740	+56 28 29	19.419	15 vS stell
286	11 2 54.6	3.5647	+56 11 43	19.429	15 vS sbM stell N
287	11 3 8.0	3.5613	+56 6 26	19.435	17 vS N
288	11 3 12.3	3.5620	+56 11 17	19.435	16 vS sbN R Spiral?
289	11 3 22.7	3.5523	+55 58 43	19.439	14 vS neb*
290	11 4 32.2	3.5510	+56 12 9	19.463	17 vS stell
291	11 4 44.8	3.5467	+56 4 9	19.467	15 S R sbM N Spiral
292	11 4 47.7	3.5469	+56 5 40	19.468	17 vS R neb*
293	11 4 57.3	3.5437	+55 59 16	19.471	17 vS stell
294	11 5 6.2	3.5426	+56 0 26	19.474	Two 18 mag. objects, iF, close together
295	11 5 16.1	3.5379	+55 48 58	19.478	16 vS. Uniform brightness
296	11 5 20.8	3.5431	+56 8 46	19.479	17 vS iF stell
297	11 5 22.1	3.5373	+55 49 20	19.480	15 vS R gbM N Spiral
298	11 5 35.2	3.5408	+56 8 18	19.484	16 vS R gbM
299	11 5 42.3	3.5387	+56 4 33	19.487	18 vS sbM N Ring
300	11 5 50.5	3.5412	+56 16 58	19.490	17 vS sbM N Spiral?
301	11 5 54.8	3.5299	+55 40 11	19.493	vvF E75°
302	11 5 58.2	3.5290	+55 37 33	19.494	S vF R
303	11 6 1.6	3.5352	+56 1 39	19.494	16 vS R sbM N Spiral
304	11 6 6.1	3.5322	+55 53 51	19.495	17 vS gbM iF
305	11 6 8.8	3.5347	+56 3 23	19.496	17 S vmE85°
306	11 6 12.5	3.5292	+55 45 22	19.499	vF E100° spindle shaped
307	11 6 19.1	3.5312	+55 56 37	19.500	17 vS dif
308	11 6 23.7	3.5305	+55 56 44	19.501	vS iF dif
309	11 6 27.1	3.5300	+55 56 40	19.502	17 vS gbM iF
310	11 6 28.4	3.5303	+55 58 4	19.503	16 vS sbM N Spiral
311	11 6 42.0	3.5330	+56 13 33	19.507	16 vS bM E 150°
312	11 6 43.0	3.5297	+56 3 13	19.508	17 vS dif iF
313	11 6 45.0	3.5298	+56 4 18	19.508	17 vS dif iF
314	11 6 51.1	3.5313	+56 12 24	19.510	17 vS sbM N Spiral
315	11 6 55.4	3.5262	+55 57 11	19.512	16 vS R sbM N Spiral
316	11 7 6.7	3.5295	+56 13 36	19.516	13 S sbM N Spiral E70°
317	11 7 10.±	...	+56 14 0±	...	16 vS stell iF neb?
318	11 7 15.9	3.5304	+56 21 9	19.519	15 vS R sbM N Spiral
319	11 7 23.9	3.5248	+56 5 58	19.522	15 vS neb*
320	11 7 32.4	3.5239	+56 7 1	19.525	16 vS sbM N Spiral
321	11 7 57.5	3.5230	+56 15 58	19.533	16 vS gbM E25°
322	11 7 59.6	3.5172	+55 57 47	19.534	16 vS neb*
323	11 8 1.8	3.5117	+55 36 17	19.534	pB S R
324	11 8 3.4	3.5177	+56 1 13	19.536	16 vS sbM
325	11 8 4.9	3.5153	+55 51 25	19.536	S F gbM E100°
326	11 8 17.4	3.5200	+56 15 18	19.540	12 S gbN be Spiral E30°
327	11 8 25.0	3.5178	+56 12 21	19.543	17 vS stell
328	11 8 46.3	3.5117	+56 1 58	19.550	15 vS stell N
329	11 8 59.2	3.5043	+55 38 13	19.553	pB S E160°
330	11 9 10.7	3.5006	+55 30 18	19.556	B irr B*n
331	11 9 20.7	3.5034	+55 45 42	19.559	vS B E100° bM
332	11 9 38.0	3.4948	+55 23 27	19.565	S pF R another apparently distinct neb np
333	11 9 41.7	3.5046	+56 0 2	19.566	L B pmbM R
334	11 9 56.7	3.4978	+55 43 41	19.571	vS B E135° spindle shaped
335	11 10 14.5	3.4873	+55 14 57	19.578	S B E90° gbM
336	11 10 28.9	3.4870	+55 19 48	19.581	S pF E135° companion n
337	11 10 43.8	3.4929	+55 49 55	19.587	vS F E100° bf
338	11 10 58.5	3.4913	+55 14 50	19.592	S B R vmbM
339	11 11 1.0	3.4817	+55 17 47	19.593	S B E45° bsf
340	11 11 4.2	3.4809	+55 16 23	19.594	B Spiral
341	11 11 36.5	3.4780	+55 21 45	19.604	vvF S R
342	11 12 23.8	3.4719	+55 23 11	19.619	vB S eE170°
343	11 13 21.2	3.1360	+13 15 33	19.632	B S R neb*
344	11 13 22.7	3.1362	+13 17 29	19.633	S F gbM
345	11 25 13.4	3.2933	+47 34 7	19.818	S pB N
346	11 26 40.5	3.3848	+47 39 8	19.836	vS F
347	11 27 2.8	3.2828	+47 42 13	19.840	vS F
348	11 27 10.3	+3.2774	+47 2 45	−19.842	vS F gbM

No.	α 1900.0			Precession.	δ 1900.00			Precession.	Description.
	h	m	s	s	°	′	″	″	
349	11	27	28.6	+3.2797	+47	38	54	−19.846	vS B vmbM Spiral
350	11	27	41.9	3.2757	+47	16	48	19.848	vS B E135°
351	11	28	18.1	3.2698	+46	59	22	19.856	vS F
352	11	28	50.2	3.2694	+47	24	46	19.862	vS B
353	11	29	23.4	3.2668	+47	32	31	19.869	vS vB N E100°
354	11	30	3.6	3.2603	+47	13	56	19.877	pS pF
355	12	10	36.7	3.0230	+38	30	36	20.026	S pB bf
356	12	10	45.3	3.0232	+38	4	44	20.025	S pB E95°
357	12	10	51.8	3.0218	+38	34	3	20.025	S pB bf
358	12	11	18.1	2.9996	+47	51	36	20.025	15 vS stell
359	12	11	27.3	2.9987	+47	49	2	20.024	15 vS E135° sbM N Spiral
360	12	11	46.7	2.9956	+48	6	2	20.022	16 S E65°
361	12	11	48.5	2.9961	+47	55	0	20.022	15 vS R sbM sN Spiral
362	12	11	50.1	3.0176	+38	27	34	20.021	S vF
363	12	12	7.0	2.9935	+48	5	58	20.020	15 vS R
364	12	12	12.2	3.0536	+14	45	22	20.019	17 vS R bM
365	12	12	16.4	3.0529	+15	10	26	20.019	18 vS R
366	12	12	19.7	3.0532	+14	54	6	20.018	18 vS R
367	12	12	23.2	3.0527	+15	11	34	20.018	18 vS vF dif
368	12	12	23.5	3.0535	+14	39	45	20.018	18 vS E160°
369	12	12	25.7	3.0529	+15	1	40	20.018	18 vS R
370	12	12	36.3	2.9903	+48	5	25	20.017	16 vS dif vgbM
371	12	12	42.0	3.0529	+14	45	51	20.016	18 vS vF R
372	12	12	44.4	3.0530	+14	38	8	20.016	18 vS dif
373	12	12	45.0	3.0145	+37	57	9	20.016	S F R
374	12	12	45.6	2.9909	+47	38	17	20.016	16 vS iF
375	12	12	51.5	3.0526	+14	44	42	20.016	18 vS R bs
376	12	12	54.4	2.9895	+47	45	31	20.016	17 vS iF dif
377	12	12	54.6	3.0523	+14	54	0	20.015	18 vS E110°
378	12	12	56.2	3.0521	+15	0	2	20.015	17 vS R bM
379	12	13	2.0	3.0519	+15	2	28	20.015	17 vS R N
380	12	13	5.6	3.0515	+15	15	4	20.014	18 vS vF dif
381	12	13	7.9	3.0518	+15	0	8	20.014	18 vS R bM
382	12	13	9.5	3.0515	+15	12	43	20.014	17 vS R N
383	12	13	13.1	3.0120	+38	6	46	20.014	vS vF
384	12	13	30.1	3.0108	+38	4	43	20.013	S F
385	12	13	33.8	3.0108	+37	57	29	20.013	pL vF R
386	12	13	36.6	3.0510	+15	4	41	20.012	18 vS R
387	12	13	37.3	3.0514	+14	47	32	20.012	18 vS R N
388	12	13	43.8	3.0512	+14	47	28	20.011	18 vS R
389	12	13	53.1	3.0505	+15	6	48	20.010	18 vS E120°
390	12	13	53.6	3.0506	+15	4	0	20.010	17 vS E100° N
391	12	13	57.4	3.0505	+15	3	34	20.010	18 vS R N
392	12	13	58.6	3.0510	+14	40	44	20.010	19 vS vF
393	12	14	5.2	3.0508	+14	41	10	20.009	18 vS R bn
394	12	14	6.2	3.0502	+15	5	31	20.009	19 vS E110° stell N
395	12	14	12.7	2.9815	+47	38	45	20.009	17 vS sbM Spiral
396	12	14	22.8	3.0497	+15	8	31	20.008	18 vS E130°
397	12	14	25.3	3.0499	+14	57	48	20.008	17 vS R N
398	12	14	31.1	3.0497	+14	58	50	20.007	18 vS R
399	12	14	44.0	3.0496	+14	50	50	20.006	18 vS R N
400	12	14	49.2	3.0489	+15	11	38	20.005	18 vS vF
401	12	15	4.9	3.0490	+14	53	4	20.004	18 vS dif
402	12	15	5.0	3.0492	+14	41	30	20.004	18 vS R two N
403	12	15	11.0	3.0643	+ 4	45	22	20.003	pF vE15°
404	12	15	11.1	3.0483	+15	13	37	20.003	17 vS E120° bM
405	12	15	22.7	3.0482	+15	6	45	20.002	17 vS R
406	12	15	31.2	3.0484	+14	47	34	20.002	18 vS E150°
407	12	15	39.3	3.0478	+15	11	10	20.001	18 vS R
408	12	16	10.5	3.0638	+ 5	11	15	19.997	F pS
409	12	16	12.4	3.0647	+ 4	37	52	19.997	vF S bn
410	12	16	31.2	3 0438	+16	32	16	19.995	16 S E0° sbM N Spiral
411	12	16	34.7	3.0442	+16	18	0	19.995	16 S sbM stell N R Spiral ?
412	12	16	36.7	3.0442	+16	13	30	19.994	18 vS iF
413	12	16	49.6	3.0439	+16	12	0	19.993	17 vS gbM iF
414	12	17	3.5	3.0432	+16	21	14	19.991	18 S dif iF E135°
415	12	17	5. ±	3.0446	+15	56	30±	19.991	17 vS sbM Spiral N
416	12	17	5.2	3.0431	+16	23	20	19.991	18 vs bs R
417	12	17	12.1	3.0638	+ 4	50	23	19.991	F vS lE50°
418	12	17	14.3	+3.0429	+16	21	16	19.990	17 vS dif gbM R

No.	α 1900.0			Precession.	δ 1900.0			Precession.	Description.
	h	m	s	s	°	′	″	″	
419	12	17	15.6	+3.0430	+16	17	18	−19.990	16S sbM N Spiral
420	12	17	21.0	3.0633	+5	7	14	19.990	! pB L Spiral
421	12	17	29.5	3.0639	+4	41	53	19.989	vF vS
422	12	17	37.0	3.0639	+4	41	13	19.989	vF vS lE45°
423	12	17	57.9	3.0414	+16	27	36	19.985	17S gbM Spiral E135°
424	12	18	5.1	3.0633	+4	54	53	19.986	vvF vs
425	12	18	16.2	3.0411	+16	22	30	19.983	15S sbM N Spiral ?
426	12	18	17.4	3.0409	+16	25	22	19.983	18vS stell N Spiral
427	12	18	19.3	3.0629	+5	0	40	19.983	eeF S
428	12	18	34.6	3.0352	+18	54	45	19.981	18vS R diffic
429	12	18	40.4	3.0352	+18	49	41	19.980	18vS vF E160″
430	12	19	17.4	3.0388	+16	37	37	19.976	17vS R gbN Spiral
431	12	19	45.5	3.0333	+18	45	1	19.972	15vS E45° stell N
432	12	20	0.7	3.0399	+16	15	57	19.971	18 vS iF
433	12	20	9.1	3.0374	+16	38	51	19.970	17 S gbM N E60° Spiral on edge
434	12	20	10.9	3.0372	+16	40	27	19.970	17 vS R sbM N Spiral
435	12	20	21.3	3.0322	+18	41	40	19.968	18 vS R bM
436	12	20	21.8	3.0369	+16	40	40	19.968	18 vS iF dif
437	12	20	22.8	3.0314	+19	2	32	19.968	18 vS R
438	12	20	35.2	3.0323	+18	26	52	19.966	18 vS R bM
439	12	20	40.8	3.0307	+19	4	16	19.966	18 vS vF R
440	12	21	21.9	3.0296	+18	59	58	19.960	18 vS R bM
441	12	21	39.2	3.0296	+18	41	29	19.958	18 vs R
442	12	21	55.3	3.0297	+18	35	37	19.956	17 vs R bM
443	12	21	56.5	3.0282	+19	4	14	19.956	18 vS R bM
444	12	21	59.8	3.0290	+18	42	0	19.956	18 vS E120°
445	12	22	13.3	3.0282	+18	49	7	19.954	17 vS R bM
446	12	25	24.7	3.0336	+14	42	46	19.924	14 S E60°
447	12	25	35.6	3.0320	+15	8	33	19.922	18 vS dif
448	12	25	47.1	3.0316	+15	11	13	19.921	15 vS bM iF
449	12	25	49.9	3.0317	+15	6	17	19.920	16 vS gbM
450	12	25	53.0	3.0312	+15	19	36	19.920	16 S E115° bM
451	12	26	0.9	3.0320	+14	54	29	19.918	16 vS R
452	12	26	0.9	3.0308	+15	20	0	19.918	17 vS iF bM
453	12	26	4.7	3.0323	+14	48	53	19.918	18 vS iF
454	12	26	8.1	3.0319	+14	55	14	19.917	16 vS R sbM N
455	12	26	12.2	3.0322	+14	44	59	19.916	12 neb*
456	12	26	17.2	3.0321	+14	44	55	19.916	16 vS iF gbM N
457	12	26	17.3	3.0323	+14	40	6	19.916	16 vS gbM N Spiral ?
458	12	26	34.7	3.0299	+15	24	49	19.913	14 S bM E165°
459	12	26	51.1	3.0308	+14	51	34	19.910	15 L mE80° bM N Spiral on edge
460	12	27	26.5	3.0636	+3	8	36	19.904	17 vS E80° gbM Spiral on edge ?
461	12	27	30.4	3.0634	+3	12	55	19.903	15 L vmE40° small spur from M
462	12	27	31.7	3.0290	+15	7	56	19.903	16 vS
463	12	27	31.8	3.0623	+3	34	13	19.903	17 vS gbM iF
464	12	27	39.2	3.0304	+14	36	16	19.902	11 L bM iF sc
465	12	27	41.6	3.0299	+14	44	55	19.902	11 neb*
466	12	27	44.2	3.0629	+3	21	0	19.900	17 vS vgbM iF
467	12	27	45.0	3.0634	+3	10	55	19.900	17 vS vgbM
468	12	27	55.1	3.0641	+2	53	13	19.899	18 vS R (Ring?)
469	12	28	10.1	3.0646	+2	42	3	19.896	17 vS R
470	12	28	18.2	3.0646	+2	42	24	19.894	16 vS ○
471	12	28	26.5	3.0648	+2	50	47	19.893	17 vS E150°
472	12	28	35.9	3.0645	+2	41	20	19.891	17 vS E160° N
473	12	28	37.4	3.0272	+15	10	32	19.891	16 vS sbM N Spiral E50°
474	12	28	43.8	3.0653	+2	25	53	19.890	16 vS gbM
475	12	28	44.0	3.0646	+2	49	52	19.890	17 vS R bM
476	12	28	50.7	3.0653	+2	24	19	19.888	18 vS vF R
477	12	28	54.3	3.0267	+15	11	50	19.887	18 vS sbM N Ring ?
478	12	28	55.5	3.0656	+2	19	2	19.887	18 vS dif
479	12	28	58.5	3.0644	+2	41	54	19.887	18 vS E130° N
480	12	29	1.7	3.0653	+2	23	42	19.886	17 vS R
481	12	29	8.9	3.0266	+15	6	23	19.885	16 vS sbM N Spiral
482	12	29	15.8	3.0614	+3	39	39	19.883	17 vS stell
483	12	29	15.8	3.0615	+3	39	15	19.883	18 vS N ? Spiral ?
484	12	29	27.0	3.0635	+2	58	4	19.881	18 vS dif iF
485	12	29	28.7	3.0636	+3	7	14	19.881	17 vS sbM N Spiral
486	12	29	30.5	3.0650	+2	27	49	19.881	17 vS R stell N
487	12	29	40.8	3.0616	+3	33	41	19.879	17 vS bM N Spiral
488	12	29	42.7	+3.0635	+2	55	34	−19.879	17 vS R

No.	α 1900.0			Precession.	δ 1900.0			Precession.	Description.
	h	m	s	s	°	′	″	″	
489	12	29	45.4	+3.0650	+ 2	26	4	−19.878	17 vS E90° N
490	12	29	51.4	3.0620	+ 3	24	29	19.877	17 vS iF
491	12	29	55.3	3.0652	+ 2	21	0	19.876	17 vS R N
492	12	29	56.6	3.0632	+ 3	0	22	19.876	18 vS R N
493	12	29	57.1	3.0652	+ 2	20	13	19.876	17 vS R
494	12	29	58.5	3.0653	+ 2	19	14	19.876	18 vS R
495	12	30	3.3	2.9859	+26	19	54	19.875	15 vS R bM
496	12	30	4.2	3.0652	+ 2	20	7	19.875	18 vS R
497	12	30	6.6	3.0616	+ 3	33	6	19.874	17 vS bs iF
498	12	30	11.2	3.0616	+ 3	30	36	19.873	17 vS stell
499	12	30	12.4	3.0649	+ 2	25	7	19.873	18 vS R
500	12	30	12.8	2.9853	+26	22	24	19.873	17 vS R bM
501	12	30	14.8	3.0648	+ 2	26	29	19.873	18 vS E70°
502	12	30	27.3	3.0648	+ 2	26	16	19.870	18 vS RbM
503	12	30	28.4	3.0648	+ 2	26	41	19.870	17 vS R bM
504	12	30	29.0	3.0651	+ 2	19	36	19.870	16 vS R
505	12	30	30.6	3.0613	+ 3	35	6	19.870	15 L vmE165° sbM Spiral
506	12	30	32.2	3.0650	+ 2	22	17	19.869	18 vS R bM
507	12	30	35.8	3.0642	+ 2	37	39	19.869	18 vS R
508	12	30	36.8	2.9840	+26	24	5	19.868	14 S E135° N
509	12	30	39.5	3.0643	+ 2	34	25	19.868	18 vS R
510	12	30	39.7	3.0645	+ 2	29	55	19.868	18 vS R
511	12	30	42.6	3.0648	+ 2	25	14	19.867	18 vS R bM
512	12	30	43.7	2.9819	+26	50	17	19.867	17 vS E40°
513	12	30	44.2	2.9822	+26	46	25	19.867	15 vS N E50°
514	12	30	52.0	3.0648	+ 2	22	56	19.866	17 vS R
515	12	30	52.6	3.0619	+ 3	19	59	19.866	17 vS sbM Spiral E110°
516	12	31	22.5	2.9809	+26	38	7	19.859	18 vS R
517	12	31	32.7	2.9797	+26	47	58	19.857	18 vS R
518	12	31	39.6	2.9794	+26	47	9	19.856	16 vS R N
519	12	31	46.1	2.9796	+26	39	51	19.855	17 vS R N
520	12	32	6.9	2.9787	+26	38	28	19.850	17 vS R N
521	12	32	21.2	2.9784	+26	31	56	19.848	18 vS vF R
522	12	32	22.7	2.9777	+26	42	36	19.847	18 vS R bM
523	12	22	29.7	2.9777	+26	37	36	19.846	18 vS R bM
524	12	32	34.2	2.9780	+26	28	24	19.845	16 neb*
525	12	32	49.7	2.9758	+26	50	59	19.842	18 vS vF E135° D
526	12	35	41.0	2.9371	+33	7	48	19.805	16 vS E140° bM
527	12	36	34.4	2.9348	+32	56	17	19.792	17 vS R bM
528	12	36	45.3	2.9340	+32	56	48	19.790	18 vS E80°
529	12	36	54.9	2.9309	+33	24	23	19.787	17 vS E0° D
530	12	37	14.3	2.9303	+33	18	35	19.781	15 vS E125° N Spiral on edge
531	12	38	9.9	2.9291	+32	52	38	19.770	18 vS bM E140°
532	12	38	13.8	2.9277	+33	6	12	19.769	18 vS R
533	12	38	15.0	2.9279	+33	2	21	19.768	14 vS E145° bM
534	12	38	33.3	2.9247	+33	26	3	19.764	15 neb*
535	12	38	35.6	2.9268	+33	0	52	19.764	16 neb*
536	12	38	41.7	2.9267	+32	56	47	19.762	18 vS R
537	12	38	45.4	2.9259	+33	2	53	19.761	18 vS R
538	12	44	9.3	2.8448	+41	38	45	19.677	18 vS R N
539	12	44	30.5	2.8431	+41	38	16	19.670	15 vS E60° Spiral?
540	12	44	31.8	2.8425	+41	41	45	19.670	18 vS vR dif
541	12	44	36.3	2.8424	+41	39	31	19.669	18 vS vF R diffic
542	12	44	39.0	2.8418	+41	41	51	19.668	18 vS R diffic
543	12	44	46.6	2.8401	+41	49	26	19.666	17 vS R bM
544	12	44	46.9	2.9440	+26	19	4	19.666	16 vS E60° bM
545	12	44	47.5	2.8417	+41	23	51	19.666	18 vS R bM
546	12	44	52.4	2.8423	+41	30	43	19.664	17 vS R
547	12	44	55.4	2.8398	+41	46	30	19.663	18 vS vF R diffic
548	12	44	56.5	2.8426	+41	25	53	19.663	18 vS R
549	12	45	8.4	2.8376	+41	54	40	19.659	18 vS vF dif D?
550	12	45	16.5	2.8412	+41	23	26	19.657	16 vS E80° bM Spiral?
551	12	45	16.9	2.9453	+25	50	0	19.657	17 vS R bM
552	12	45	21.5	2.8404	+41	26	8	19.656	16 vS R bM
553	12	45	27.0	2.8395	+41	29	21	19.654	18 vS vF E150° bM Spiral on edge
554	12	45	28.2	2.9448	+25	50	38	19.654	18 vS R
555	12	45	29.3	2.9442	+26	13	28	19.653	17 vS E50° bs
556	12	45	30.5	2.9444	+26	14	10	19.653	17 vS R
557	12	45	43.2	2.8361	+41	44	11	19.649	17 vS R N
558	12	45	56.5	2.9436	+25	49	14	19.646	16 vS E40° N

No.	α 1900.0	Precession.	δ 1900.0	Precession.	Description.
	h m s	s	° ′ ″	″	
559	12 45 58.3	+2.9436	+25 48 13	−19.645	16 vS E35° N
560	15 45 59.1	2.8368	+41 29 16	19.645	18 vS vF R
561	12 46 10.3	2.8363	+41 25 57	19.641	18 vS vF R bM
562	12 46 22.3	2.8331	+41 56 7	19.638	15 vS E90° bs Spiral?
563	12 46 22.8	2.8358	+41 22 17	19.638	18 vS vF R ○?
564	12 46 26.4	2.8328	+41 41 43	19.637	17 vS R bM
565	12 46 26.6	2.8335	+41 35 39	19.637	18 vS R bM
566	12 46 37.8	2.8325	+41 36 5	19.633	18 vS R bM
567	12 46 46.6	2.9393	+26 9 36	19.631	16 vS E150° bM
568	12 47 5.2	2.8321	+41 22 31	19.625	18 vS R
569	12 47 13.3	2.8269	+41 54 46	19.623	17 vS R bM
570	12 47 14.6	2.8309	+41 24 52	19.622	17 vS R bM
571	12 47 24.3	2.8272	+41 46 30	19.620	18 vS R bM
572	12 47 29.8	2.8254	+41 56 1	19.618	18 vS R
573	12 47 31.6	2.9395	+25 45 4	19.618	16 vS E10° N
574	12 47 38.9	2.8258	+41 47 20	19.615	18 vS R N
575	12 47 43.7	2.8260	+41 42 48	19.614	18 vS R bM
576	12 47 53.5	2.8245	+41 48 10	19.611	18 vS dif
577	12 48 1.6	2.8256	+41 34 23	19.609	16 vS E125° bM
578	12 48 17.5	2.8252	+41 27 34	19.604	18 vS R
579	12 48 25.4	2.8217	+41 48 40	19.602	18 vS vF R
580	12 48 30.9	2.8246	+41 23 31	19.600	17 vS R N
581	12 48 31.3	2.8206	+41 53 17	19.600	18 vS vF R
582	12 48 32.9	2.8244	+41 23 30	19.600	16 vS R N
583	12 50 50.7	2.9509	+22 25 55	19.557	S R vF
584	12 51 15.7	2.9504	+22 21 0	19.549	vS vF E90°
585	13 9 17.4	2.7068	+42 33 56	19.139	18 vS R
586	13 9 24.6	2.7039	+42 44 21	19.135	14 S E150° four N
587	13 9 25.1	2.7071	+42 30 1	19.135	18 vS R
588	13 9 30.5	2.7093	+42 18 5	19.133	17 vS R bM
589	13 9 35.1	2.7083	+42 20 47	19.131	17 vS R bM
590	13 9 36.1	2.7089	+42 17 28	19.130	17 vS R bM
591	13 9 38.6	2.7084	+42 19 5	19.129	18 vS R bM
592	13 9 43.4	2.7086	+42 15 56	19.127	18 vS R
593	13 9 46.8	2.7056	+42 28 13	19.125	17 vS E120°
594	13 9 47.8	2.7078	+42 18 1	19.125	16 vS E150° bM
595	13 9 53.2	2.7077	+42 16 31	19.123	18 vS R bM
596	13 9 53.3	2.7086	+42 12 19	19.123	18 vS vF R
597	13 9 56.2	2.7042	+42 28 40	19.121	16 vS E90° bM
598	13 9 57.3	2.7028	+42 36 34	19.121	18 vS R
599	13 10 1.3	2.7084	+42 10 13	19.119	14 vS E15° gbM
600	13 10 4.6	2.7015	+42 40 5	19.117	18 vS R
601	13 10 5.4	2.6999	+42 47 12	19.117	16 vS R bM neb$_{*}$?
602	13 10 5.7	2.7054	+42 22 10	19.117	18 vS R
603	13 10 5.8	2.7061	+42 18 47	19.117	17 vS R bM
604	13 10 5.8	2.7014	+42 37 56	19.117	18 vS R N
605	13 10 7.0	2.7032	+42 31 16	19.116	17 vS E165° gbM
606	13 10 11.5	2.7018	+42 35 45	19.114	18 vS R bM
607	13 10 11.7	2.7030	+42 30 44	19.114	18 vS E50°
608	13 10 12.4	2.7030	+42 30 7	19.114	18 vS R
609	13 10 12.8	2.7009	+42 39 44	19.114	18 vS R
610	13 10 14.1	2.7027	+42 31 8	19.113	18 vS R vF
611	13 10 16.2	2.7027	+42 30 10	19.112	18 vS E70° bM
612	13 10 21.0	2.7057	+42 14 33	19.110	14 neb$_{*}$
613	13 10 22.6	2.7064	+42 10 52	19.110	18 vS vF R
614	13 10 31.3	2.7009	+42 32 28	19.105	17 vS R bM
615	13 10 32.5	2.6979	+42 45 51	19.105	18 vS R
616	13 10 38.2	2.7026	+42 22 18	19.102	18 vS R bM
617	13 10 38.9	2.7042	+42 14 22	19.102	18 vS R
618	13 10 41.2	2.7033	+42 17 50	17.101	17 vS E150° gbM
619	13 10 43.5	2.7016	+42 24 33	19.100	18 vS E80°
620	13 10 47.8	2.7041	+42 11 39	19.098	18 vS vF R
621	13 10 51.4	2.6951	+42 51 13	19.096	16 vS E75° gbM
622	13 10 53.8	2.6947	+42 52 3	19.095	17 vS E150° bM
623	13 10 57.6	2.7032	+42 11 42	19.094	18 vS R
624	13 10 58.1	2.7007	+42 22 50	19.094	17 vS R bM
625	13 11 3.2	2.7008	+42 20 46	19.091	18 vS R
626	13 11 5.9	2.7011	+42 17 58	19.090	18 vS E30°
627	13 11 8.3	2.7022	+42 12 22	19.089	17 vS R bM
628	13 11 9.6	+2.7002	+42 20 44	−19.088	18 vS vF R

No.	α 1900.0			Precession.	δ 1900.0			Precession.	Description.
	h	m	s	s	°	′	″	″	
629	13	11	15.1	+2.7001	+42	19	9	−19.086	18 vS R bM
630	13	11	19.7	2.7017	+42	10	0	19.084	18 vS E35°
631	13	11	21.3	2.6978	+42	27	13	19.083	17 vS E100° bM
632	13	11	27.5	2.6973	+42	27	7	19.080	17 vS E60° gbM
633	13	11	29.8	2.6982	+42	22	18	19.079	18 vS R
634	13	11	30.7	2.6978	+42	23	27	19.079	17 vS E75°
635	13	11	36.8	2.6985	+42	17	58	19.076	17 vS R N
636	13	11	38.3	2.6935	+42	40	21	19.075	18 vS R
637	13	11	38.6	2.6973	+42	22	44	19.075	18 vS E110°
638	13	11	40.2	2.6925	+42	43	58	19.075	18 vS E125°
639	13	11	43.0	2.6960	+42	27	5	19.073	17 vS E130° gbM
640	13	11	44.1	2.6972	+42	21	11	19.073	18 vS R
641	13	11	50.0	2.6933	+42	36	47	19.070	17 vS R bM
642	13	11	51.6	2.6967	+42	20	17	19.070	17 vS R bM
643	13	11	53.9	2.6963	+42	21	24	19.068	18 vS R bM
644	13	11	54.9	2.6964	+42	20	41	19.068	18 vS R bM
645	13	11	57.0	2.6963	+42	20	7	19.067	17 vS E110° gbM
646	13	11	58.6	2.6949	+42	25	54	19.066	18 vS R
647	13	12	15.4	2.6903	+42	40	36	19.059	18 vS R
648	13	12	24.1	2.6907	+42	35	22	19.055	17 vS R N
649	13	12	29.4	2.6861	+42	54	15	19.053	17 vS E130°
650	13	12	37.4	2.6880	+42	42	38	19.049	16 vS R bM; neb* ?
651	13	12	38.9	2.6893	+42	35	47	19.048	18 vS R
652	13	12	39.7	2.6862	+42	49	45	19.048	17 vS E45°
653	13	12	44.7	2.6885	+42	37	23	19.046	18 vS R
654	13	12	56.6	2.6872	+42	38	34	19.040	18 vS R
655	13	13	4.2	2.6861	+42	40	46	19.037	18 vS R
656	13	13	11.7	2.6913	+42	13	29	19.033	17 vS R bM
657	13	13	11.8	2.6850	+42	42	56	19.033	18 vS vF dif
658	13	13	19.6	2.6877	+42	27	12	19.030	18 vS E160°
659	13	13	21.4	2.6829	+42	48	36	19.029	18 vS R
660	13	13	22.0	2.6878	+42	25	44	19 029	18 vS R
661	13	13	22.8	2.6837	+42	44	34	19.029	17 vS R N
662	13	13	28.2	2.6825	+42	47	49	19.026	18 vS vF R
663	13	13	36.3	2.6830	+42	42	9	19.023	17 vS R bM
664	13	13	57.0	2.6802	+42	47	4	19.014	18 vS R
665	13	14	2.4	2.6802	+42	44	54	19.011	17 vS R bM
666	13	23	5.2	2.5574	+47	23	8	18.746	vS eeF
667	13	24	19.1	2.5489	+47	26	42	18.707	B pL E80°
668	13	26	4.1	2.5313	+47	49	42	18.651	vS eF
669	13	26	15.2	2.5313	+47	45	47	18.644	S pB lE135°
670	13	27	7.8	2.5273	+47	41	54	18.616	S eeF
671	13	27	19.5	2.5333	+47	18	40	18.610	F S R
672	13	27	33.2	2.5315	+47	20	14	18.602	vS vF E90°
673	13	31	34.8	3.2319	−17	4	23	18.468	16 vS E150°
674	13	31	38.8	3.2351	−17	22	4	18.466	16 vS E150° bM
675	13	31	47.9	3.2332	−17	9	33	18.460	18 vS R
676	13	31	52.4	3.2335	−17	10	52	18.458	18 vS E50°
677	13	31	52.5	3.2339	−17	12	47	18.458	18 vS bn dif
678	13	32	54.9	3.2386	−17	29	57	18.422	17 vS bM E105°
679	13	57	42.5	2.1379	+54	54	5	17.461	B S E90° neb* ?
680	14	1	50.9	2.1136	+54	44	50	17.280	S pF bp
681	14	2	3.1	2.1055	+54	56	17	17.272	pB L i
682	15	0	8.1	1.6712	+55	59	2	14.170	18 vS R bM
683	15	0	32.4	1.6694	+55	58	21	14.144	18 vS vF E110°
684	15	0	33.7	1.6634	+56	4	52	14.143	17 vS E160°
685	15	1	2.9	1.6722	+55	51	53	14.113	17 vS R bM
686	15	1	4.1	1.6638	+56	0	58	14.111	17 vS R bM
687	15	1	30.4	2.7322	+19	40	56	14.082	S R F
688	15	1	32.3	2.7225	+20	11	15	14.080	S pF E45°
689	15	1	37.2	2.7251	+20	3	1	14.075	vS F E10°
690	15	2	31.5	1.6443	+56	12	53	14.018	16 vS R bM
691	15	2	49.2	2.7273	+19	49	56	13.999	pS F gbM
692	15	2	59.6	1.6345	+56	20	44	13.989	17 vS R bs
693	15	3	18.1	1.6535	+55	57	34	13.970	13 neb*
694	15	3	29.0	2.7243	+19	56	29	13.958	vF S R
695	15	3	30.9	1.6493	+56	0	49	13.956	16 vS N E105°
696	15	3	34.9	2.7213	+20	5	39	13.952	vS F E45°
697	15	3	40.9	2.7207	+20	7	7	13.946	vF pL Spiral
698	15	3	47.8	+1.6564	+55	51	5	−13.939	17 vS E45°

No.	α 1900.0			Precession.	δ 1900.0			Precession.	Description.
	h	m	s	s	°	′	″	″	
699	15	3	54.2	+1.6479	+55	59	40	−13.932	17 vS bM E135°
700	15	3	56.8	2.7242	+19	54	41	13.929	vS F
701	15	4	23.7	2.7281	+19	40	23	13.901	F pL gbM Spiral ?
702	15	4	28.2	2.7248	+19	50	25	13.896	pB S E90°
703	15	4	31.9	1.6563	+55	46	6	13.892	18 vS E35°
704	15	5	45.5	1.6277	+56	20	45	13.815	17 vS R N
705	15	5	52.1	1.6401	+55	55	5	13.807	18 vS R N
706	15	6	37.4	1.6263	+56	5	17	−13.760	18 vS R bM
707	22	29	41.0	2.7214	+34	22	53	+18.513	F S E90°
708	22	30	38.1	2.7299	+33	58	36	18.544	F S R
709	22	30	54.8	2.7306	+34	0	21	18.552	F pS vmbM
710	22	31	3.1	2.7344	+33	44	58	18.557	pB vS mE90° vmbM
711	22	31	17.6	2.7303	+34	8	35	18.566	vF vS mE160°
712	22	31	43.9	2.7334	+34	1	32	18.579	F pL i * inv
713	22	32	1.5	2.7394	+33	42	15	18.588	vF S mE140°
714	22	32	29.8	2.7324	+34	19	13	18.603	pB vS gmbM
715	22	32	33.2	2.7354	+34	6	5	18.605	vF pL gbM
716	22	32	46.2	2.7393	+33	51	20	18.612	D * inv set on p*
717	22	32	50.3	2.7347	+34	13	53	18.614	pB S E0° vmbM
718	22	33	1.3	2.7406	+34	19	38	18.620	vB S lE50° vmbM
719	22	33	37.7	2.7361	+34	21	1	18.640	pF pL lE90°
720	22	33	50.5	2.7448	+33	43	16	18.647	Neb*
721	22	33	58.1	2.7410	+34	4	9	18.651	vF pS E45°
722	22	34	0.6	2.7442	+33	49	6	18.652	F S E20°
723	22	34	10.8	2.7453	+33	46	59	18.658	F pL gbM
724	23	8	29.3	3.0514	+ 4	0	38	19.543	B vS E135°
725	23	8	49.6	3.0499	+ 4	20	26	19.549	vvF S R
726	23	9	42.0	3.0515	+ 4	5	43	19.566	B S vE 170°
727	23	10	1.1	3.0529	+ 3	49	42	19.572	B S neb*
728	23	10	24.4	3.0504	+ 4	21	20	19.580	B neb*
729	23	10	28.1	3.0501	+ 4	25	14	19.581	pS vF i
730	23	11	11.5	3.0521	+ 4	5	19	19.594	S lE90°
731	23	47	4.6	3.0620	+ 7	50	21	20.016	F pL N Spiral ?
732	23	48	15.7	3.0632	+ 7	35	32	20.021	vF BN E100°. Spiral
733	23	49	39.3	3.0640	+ 7	49	26	20.027	F vS mbM lE45°
734	23	56	13.3	3.0661	+15	55	34	20.045	vvF vS
735	23	56	16.0	3.0663	+15	43	36	20.045	pB vS
736	23	56	36.9	3.0668	+15	45	12	20.045	F vS
737	23	56	40.1	3.0669	+15	45	59	20.045	F vS E60°
738	23	56	52.9	3.0657	+20	25	57	20.046	S vF F* sp
739	23	57	4.8	3.0676	+15	49	9	20.046	vF pS
740	23	58	4.0	3.0692	+15	24	34	20.046	B mE135° N
741	23	58	18.1	3.0686	+20	47	8	20.047	vS vF E45°
742	23	58	53.3	3.0705	+15	27	48	20.047	F vS
743	23	59	20.8	3.0713	+15	25	32	20.047	vvF vS
744	23	59	23.2	+3.0710	+20	9	40	+20.047	S F E170°

Abbreviations Used in Description.

The number denotes magnitude,—estimated from the negative.

vS	very small, < 30″	dif	diffused
S	small, 30″ to 2′ or 3′	diffic	difficult
L	large, > 2′ or 3′	eF	extremely faint
B	bright	g	gradually
D	double	i	irregular
E	elongated	l	little
F	faint	m	much
iF	irregular figure	p	pretty
M	middle or in the middle	pB	pretty bright
N	nucleus	pF	pretty faint
R	round	sc	scattered
b	brighter	stell	stellar
bn	brighter toward the north side	sbM	suddenly brighter toward the middle
bs	brighter toward the south side	v	very
bp	brighter toward the preceding side	vbM	very much brighter toward the middle
bf	brighter toward the following side	vS	very small
bsw	brightest toward the south-west	F*inv	faint star involved
bM	brighter toward the middle	○	planetary

Positions of Known Nebulæ Determined from the Crossley Negatives.

N. G. C.	α 1900.0			Precession.	δ 1900.0			Precession.	Remarks.
	h	m	s	s	°	′	″	″	
185	0	33	27.9	+3.2866	+47	47	8	+19.840	
247	0	42	11.0	2.9770	−21	18	21	19.708	
253	0	42	38.6	2.9526	−25	50	4	19.701	
509	1	18	9.6	3.1429	+8	54	40	18.894	
516	1	18	53.2	3.1444	+9	1	46	18.876	
518	1	19	3.0	3.1428	+8	48	32	18.871	
522	1	19	30.6	3.1486	+9	28	19	18.857	
524	1	19	33.0	3.1414	+9	1	2	18.856	
525	1	19	37.9	3.1464	+9	10	54	18.854	
532	1	20	2.5	3.1430	+8	44	35	18.841	
. .	1	21	7.3	3.1493	+9	23	21	18.810	N. G. C. Sup. 114
628	1	31	24.8	3.2141	+15	16	22	18.473	
891	2	16	17.7	3.7447	+41	53	44	16.609	
906	2	18	59.5	3.7502	+41	38	10	16.476	
1023	2	34	8.1	3.7387	+38	37	42	15.681	
1055	2	36	37.5	3.0739	+0	0	48	15.545	
1068	2	37	33.7	3.0658	−0	26	23	15.493	
1072	2	38	23.7	3.0715	−0	7	8	15.447	
1084	2	41	4.5	2.9513	−7	59	56	15.300	
1638	4	36	33.4	3.0287	−2	0	6	7.139	
1931	5	24	48.7	3.9695	+34	10	7	+ 3.067	
2366	7	18	19.3	6.4249	+69	24	51	− 6.718	
2371–2	7	19	16.4	3.7891	+29	41	13	6.797	
2403	7	27	11.7	5.8367	+65	49	13	7.445	
2624	8	32	24.2	3.4566	+20	4	24	12.370	
2683	8	46	27.6	3.7417	+33	47	51	13.317	
2841	9	15	7.8	4.1755	+51	24	3	15.080	
2903, 5	9	26	30.4	3.4065	+21	56	15	15.716	N. G. C. 2903 and 2905
3003	9	42	39.1	3.5786	+33	53	9	16.553	
3021	9	45	1.0	3.5735	+34	1	14	16.670	
3031	9	47	17.9	5.0430	+69	32	14	16.785	
3079	9	55	11.4	4.1050	+56	9	34	17.147	
3115	10	0	15.1	2.9877	−7	14	6	17.372	
3156	10	7	30.5	3.1107	+3	37	29	17.680	
3166	10	8	34.9	3.1143	+3	55	11	17.724	
3169	10	9	4.2	3.1154	+3	57	41	17.744	
3184	10	12	17.4	3.6158	+41	55	27	17.874	
3198	10	13	47.9	3.6919	+46	3	3	17.933	
3222	10	17	6.5	3.2879	+20	23	30	18.062	
3227	10	17	59.1	3.2864	+20	24	14	18.094	
3226	10	18	2.8	3.2859	+20	22	13	18.097	
. .	10	20	55.2	4.5248	+68	55	14	18.204	Coddington's Neb. in *Ursa Major.*
3556	11	5	36.8	3.5420	+56	13	0	19.485	
3587	11	9	0.1	3.5029	+55	33	47	19.553	
3623	11	13	42.8	3.1374	+13	38	23	19.639	
3627	11	15	2.2	3.1352	+13	32	18	19.662	
3726	11	27	55.4	3.2764	+47	34	50	19.851	
4226	12	11	28.2	2.9995	+47	34	53	20.024	
4231	12	11	51.1	2.9956	+48	0	46	20.022	
4232	12	11	51.2	2.9957	+47	59	39	20.022	
4244	12	12	29.4	3.0148	+38	24	34	20.017	
4248	12	12	53.1	2.9890	+47	57	52	20.016	
4254	12	13	45.0	3.0509	+14	58	19	20.011	
4258	12	14	0.8	2.9821	+47	51	35	20.010	
4292	12	16	10.3	3.0639	+5	9	1	19.997	
4303	12	16	48.7	3.0637	+5	1	42	19.993	
4321	12	17	51.0	3.0418	+16	22	36	19.986	
4379	12	20	11.2	3.0382	+16	9	43	19.970	
4382	12	20	21.3	3.0321	+18	44	45	19.968	
4394	12	20	53.0	3.0310	+18	46	7	19.964	
4501	12	26	56.6	3.0304	+14	58	21	19.909	
4516	12	28	5.1	3.0282	+15	7	38	19.898	
4527	12	29	2.2	3.0629	+3	12	19	19.886	
4533	12	29	15.6	3.0638	+2	52	39	19.884	
4536	12	29	20.6	3.0642	+2	44	22	19.883	
4565	12	31	23.3	2.9812	+26	32	20	19.859	
4627	12	37	7.3	2.9316	+33	7	22	19.784	
4631	12	37	14.4	+2.9315	+33	5	19	−19.783	

N. G. C.	α 1900.0	Precession.	δ 1900.0	Precession.	Remarks.
	h m s	s	° ′ ″	″	
4712	12 44 40.3	+2.9475	+26 0 55	-19.667	
4725	12 45 33.0	2.9434	+26 2 44	19.652	
4736	12 46 10.5	2.8344	+41 39 54	19.641	
4747	12 46 52.4	2.9381	+26 19 8	19.629	
4826	12 51 49.1	2.9499	+22 13 30	19.538	
5055	13 11 20.5	2.6965	+42 33 28	19.083	
5194	13 25 40.1	2.5358	+47 42 43	18.663	
5247	13 32 38.6	3.2368	-17 22 28	18.431	
5457	13 59 40.4	2.1264	+54 49 44	17.375	
5857	15 2 54.8	2.7244	+19 58 56	13.993	
5859	15 3 2.2	2.7245	+19 58 1	13.986	
5866	15 3 45.3	1.6405	+56 8 54	13.941	
5870	15 3 48.5	1.6556	+55 51 50	-13.938	
7315	22 30 53.4	2.7270	+34 17 8	+18.552	
7331	22 32 24.5	2.7374	+33 53 55	18.600	
7333	22 32 40.1	2.7380	+33 55 44	18.609	
7336	22 32 42.6	2.7377	+33 57 47	18.610	
7340	22 33 4.7	2.7399	+33 53 28	18.622	
7537	23 9 29.3	3.0521	+ 3 57 14	19.562	
7541	23 9 38.7	3.0520	+ 3 59 21	19.565	
7778	23 48 12.9	3.0635	+ 7 18 55	20.021	
7779	23 48 20.0	3.0636	+ 7 19 12	20.021	
7780	23 48 25.5	3.0633	+ 7 33 44	20 021	
7781	23 48 39.2	3.0638	+ 7 18 17	20.022	
7782	23 48 47.1	3.0638	+ 7 24 52	20.023	
7814	23 58 7.5	3.0693	+15 35 20	20.046	
7817	23 58 51.2	3.0699	+20 11 46	20.047	

LIST OF ILLUSTRATIONS.

LIST OF ILLUSTRATIONS—*Continued.*

No.	N. G. C. No.	Date.	Expo- sure.	Enlarge- ment.	*Orienta- tion* Top.	Remarks.
53	6205	1900, June 22	2 0	3.8	S	M 13.
54	6218	1899, July 11	2 0	3.7	S	M 12.
55	6514	1899, July 6	3 0	4.1	S	Trifid nebula.
56	6523	1899, July 7	4 0	2.0	W	M 8.
57	6543	1899, August 8	0 5	19	S	H IV, 37.
58	6618	1899, July 9	4 0	3.1	S	Omega nebula.
59	6720	1899, July 14	0 10	13	S	M 57.
60	6853	1899, July 31	3 0	3.8	S	Dumb-Bell nebula
61	6894	1899, August 9	1 0	7.2	S	H IV, 13.
62	6946	1899, August 7	4 0	3.9	S	H IV, 76.
63	6995	1899, August 29	4 0	2.2	S	Network nebula in *Cygnus*.
64	7009	1899, July 28 1899, July 30	0 10 0 2	17	S	H IV, 1. H IV, 1.
65	7023	1903, August 19–20	3 0	3.8	S	H IV, 74.
66	7217	1899, August 12	4 0	7.1	S	H II, 207.
67	7331	1899, August 11	4 0	3.8	S	H I, 53.
68	7479	1899, August 9	2 0	4.8	S	H I, 55.
69	7662	1899, September 5	10^s 20^s 30^s 1^m 2^m	17	S	H IV, 18.
70	7814	1899, September 30	3 0	4.9	S	H II, 240.

Plate I.

THE GREAT NEBULA IN ANDROMEDA

Plate 2

THE SPIRAL NEBULA H.V.I. CETI

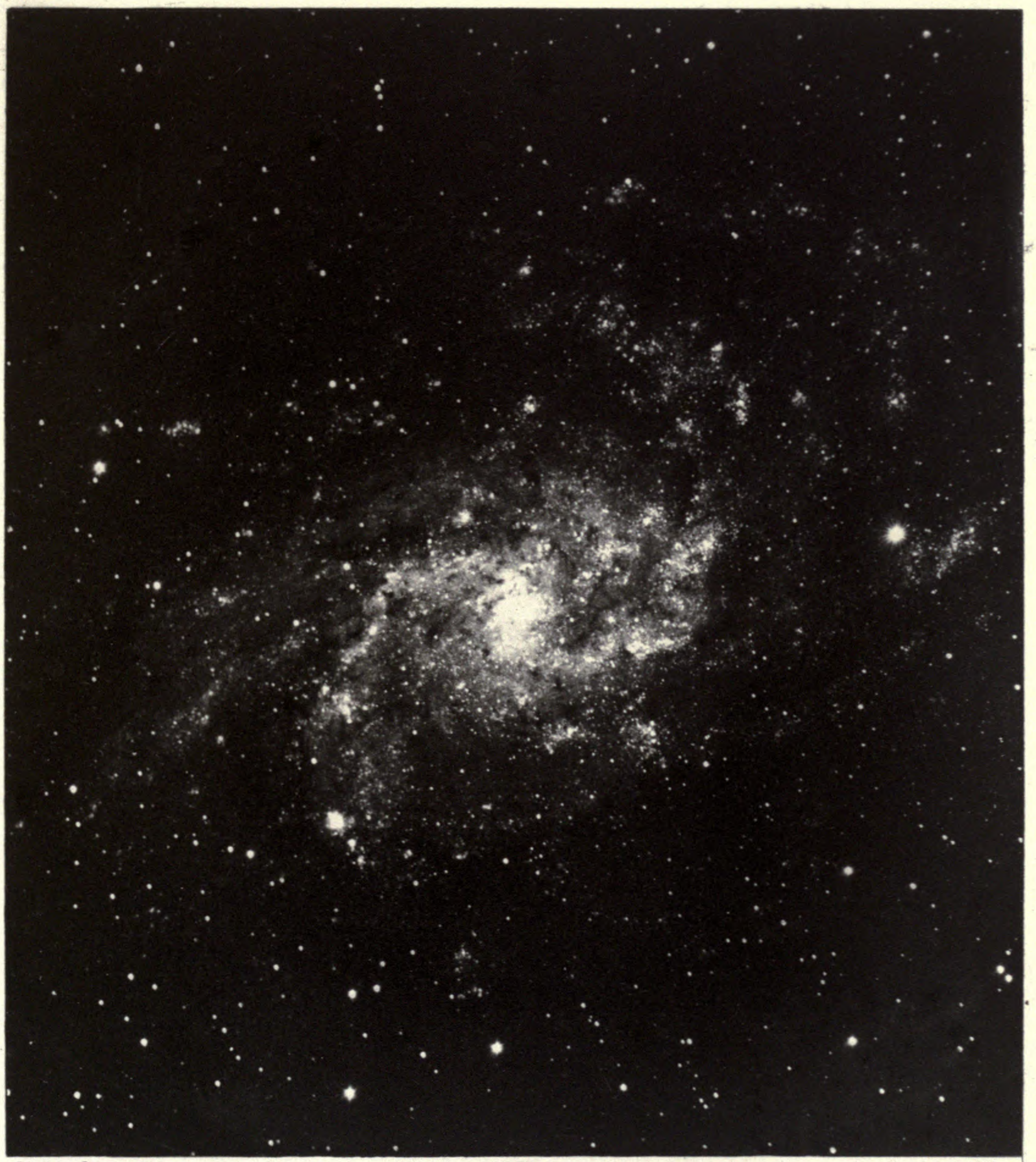


Plate 3

THE SPIRAL NEBULA M. 33 TRIANGULI

Plate 4

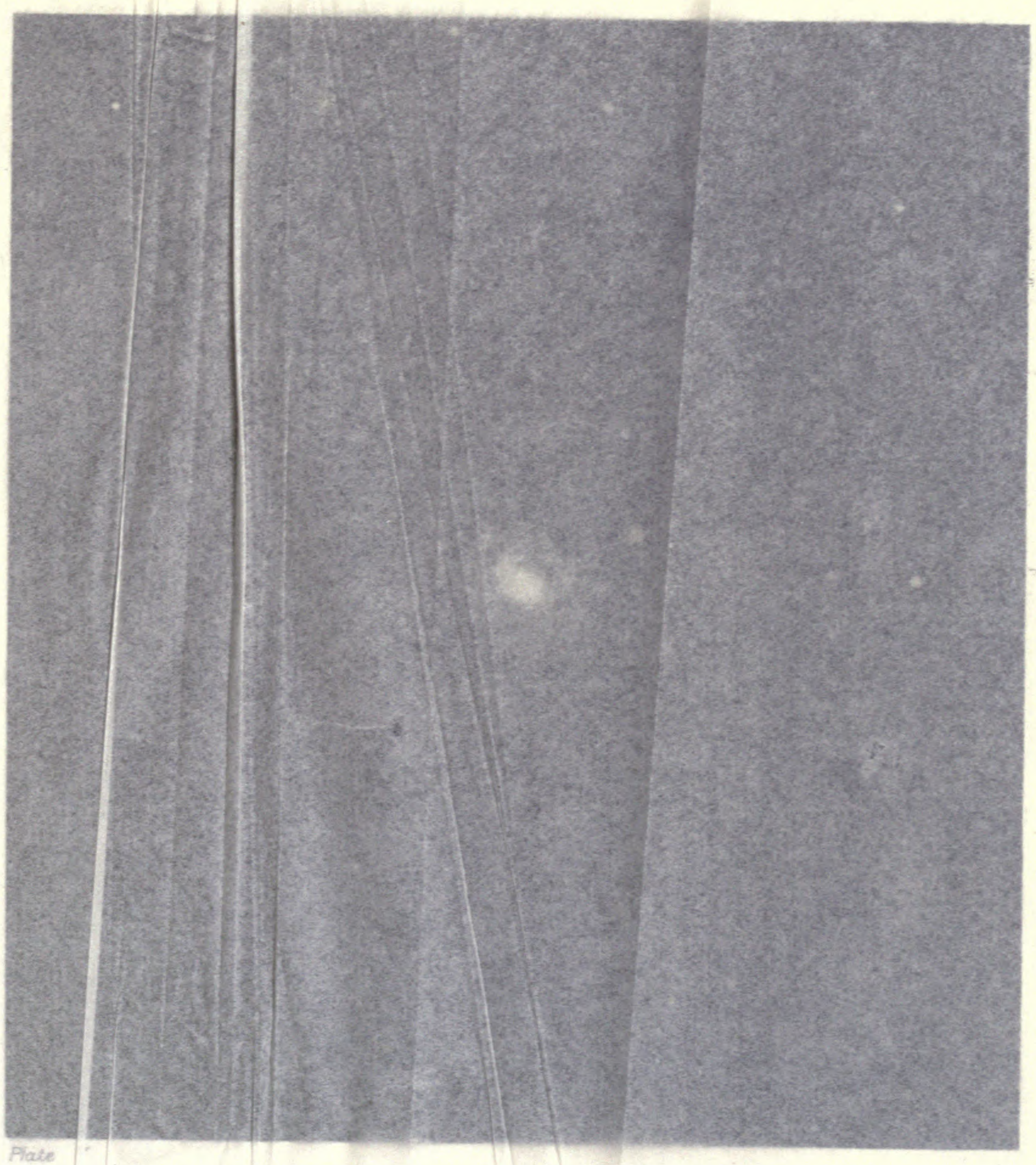
THE SPIRAL NEBULA M. 74 PISCIUM.

Plate 5

THE NEBULA M. 76 PERSEI.

Plate 6

THE NEBULA H.V. 19 ANDROMEDAE



Plate

THE SPIRAL NEBULA M 77 CETI

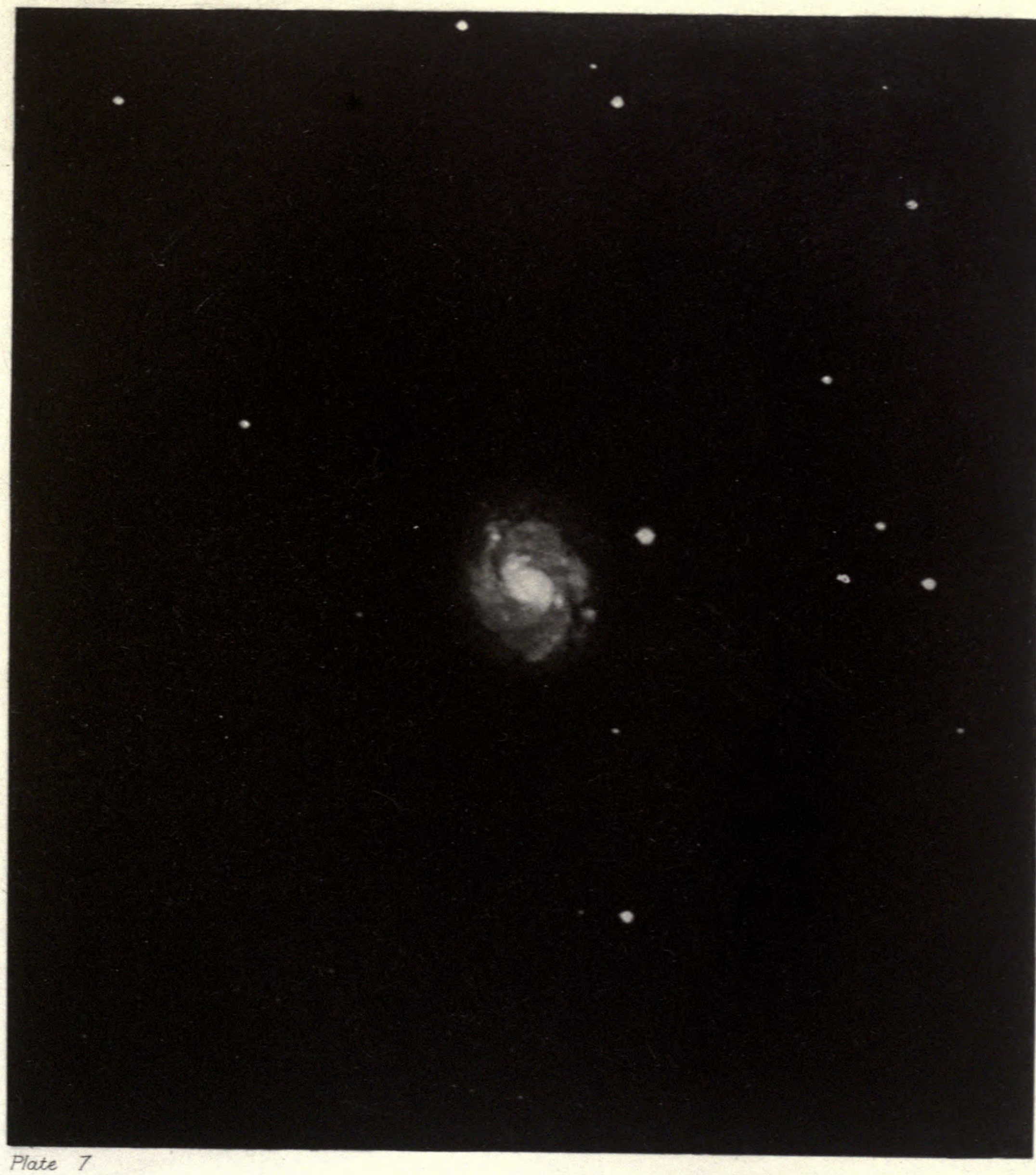


Plate 7

THE SPIRAL NEBULA M 77, CETI

Plate 8

THE PLEIADES

Plate 9

THE CRAB NEBULA IN TAURUS

Plate II

CENTRAL PORTION OF THE GREAT NEBULA IN ORION

Plate 12

THE NEBULA H.V·30, ORIONIS

Plate 13

THE NEBULA H.V. 28 ORIONIS

Plate 14

THE NEBULA M. 78 ORIONIS

Plate 15

NEBULA NEAR 15 MONOCEROTIS

Plate 16

NEW NEBULA IN MONOCEROS (ROBERTS)

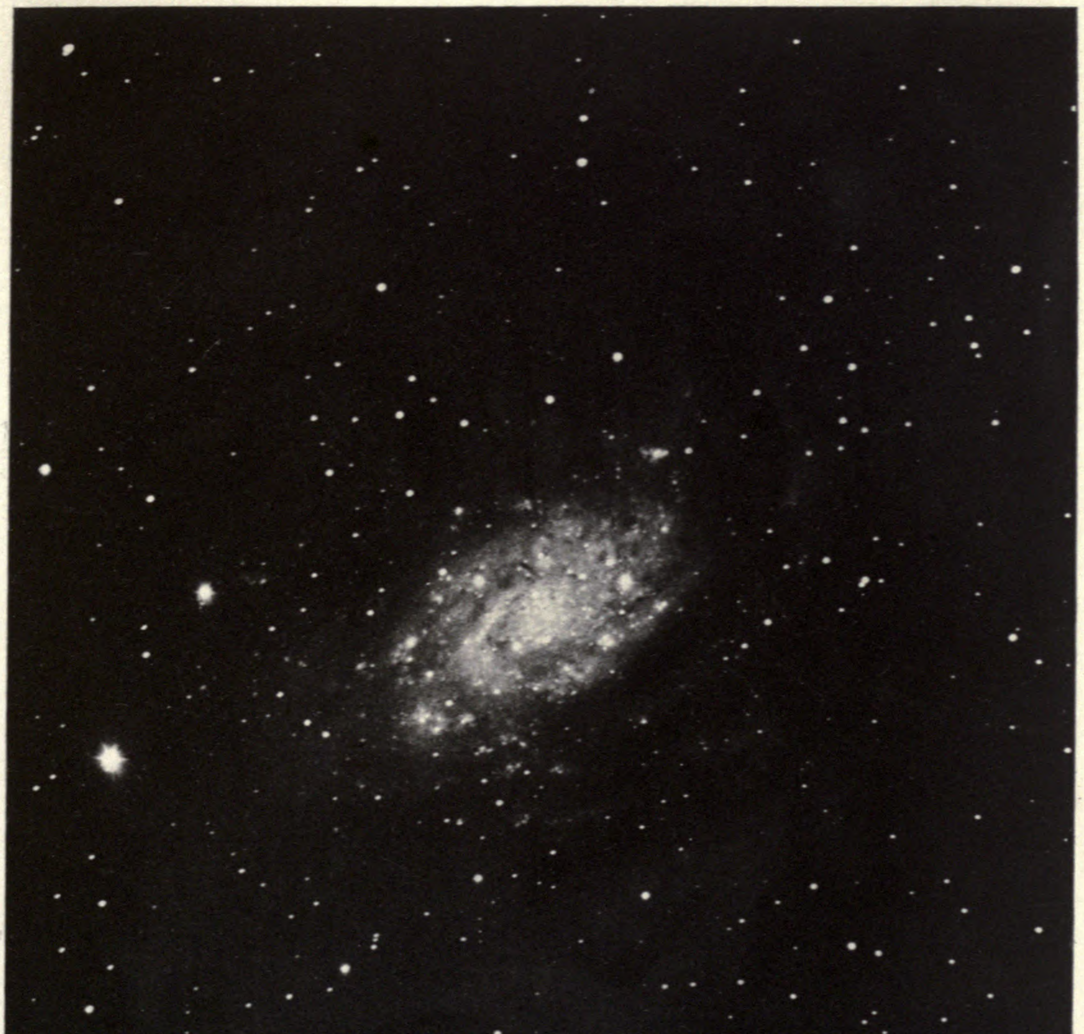


Plate 17

THE SPIRAL NEBULA H.V. 44 CAMELOPARDI

Plate 18

THE NEBULA H.I.200 LEONIS MINORIS

Plate 19

THE SPIRAL NEBULA H.I.205 URSAE MAJORIS

Plate 20

THE SPIRAL NEBULA H. I. 56-57 LEONIS

Plate 21

THE SPIRAL NEBULA M 81, URSAE MAJORIS

Plate 22

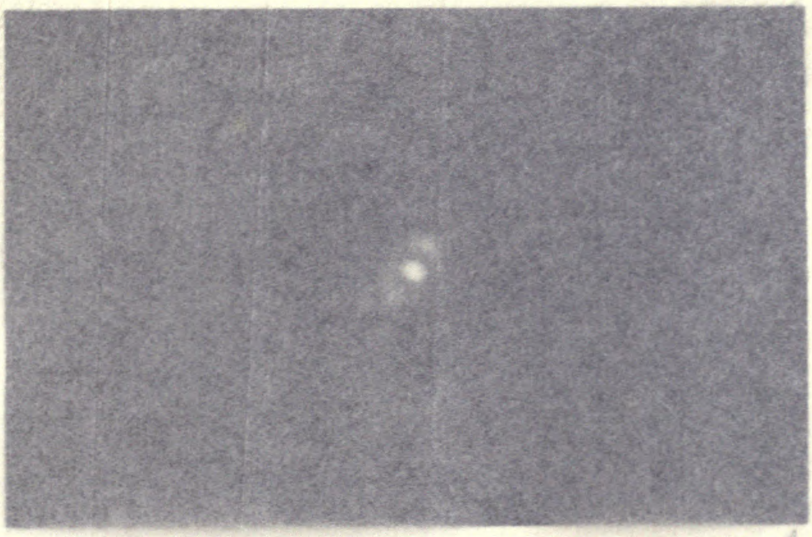
THE NEBULA H. I, 163, SEXTANTIS

Plate 23

THE SPIRAL NEBULA H.I.199, URSAE MAJORIS

Plate 24

THE DOUBLE NEBULA H.II 28-29, LEONIS



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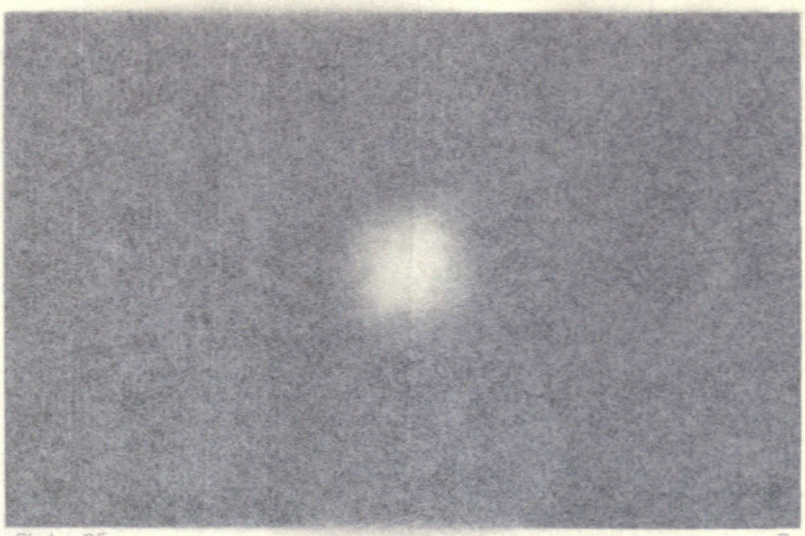
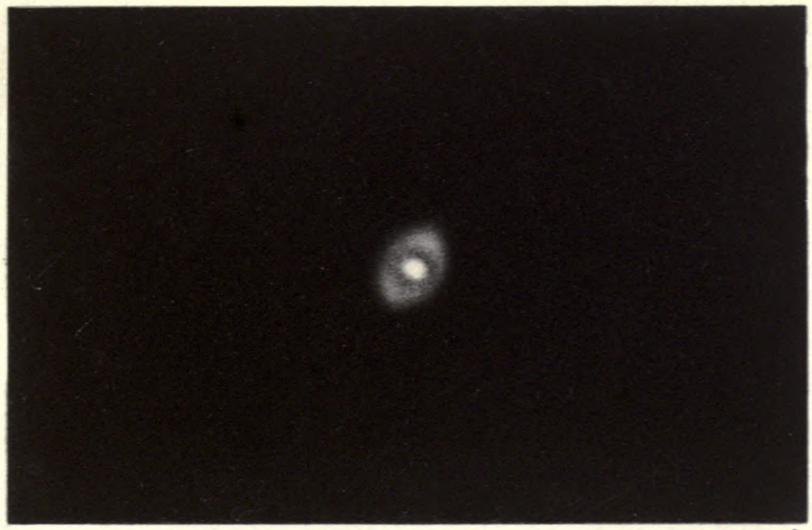


Plate 25

B

THE PLANETARY NEBULA H IV 27, HYDRAE



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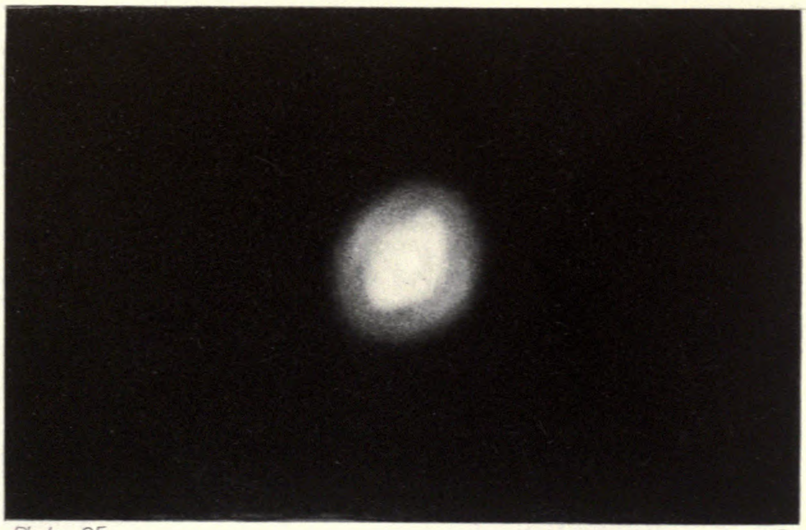


Plate 25

B

THE PLANETARY NEBULA H. IV 27, HYDRAE

Plate 26

THE NEBULA H. V 46, URSAE MAJORIS

Plate 27

THE OWL NEBULA, M 97, URSAE MAJORIS

Plate 28

THE SPIRAL NEBULA M 65, LEONIS

Plate 29

THE SPIRAL NEBULA M 66. LEONIS

Plate 30 A

THE SPIRAL NEBULA H.II 730, URSAE MAJORIS

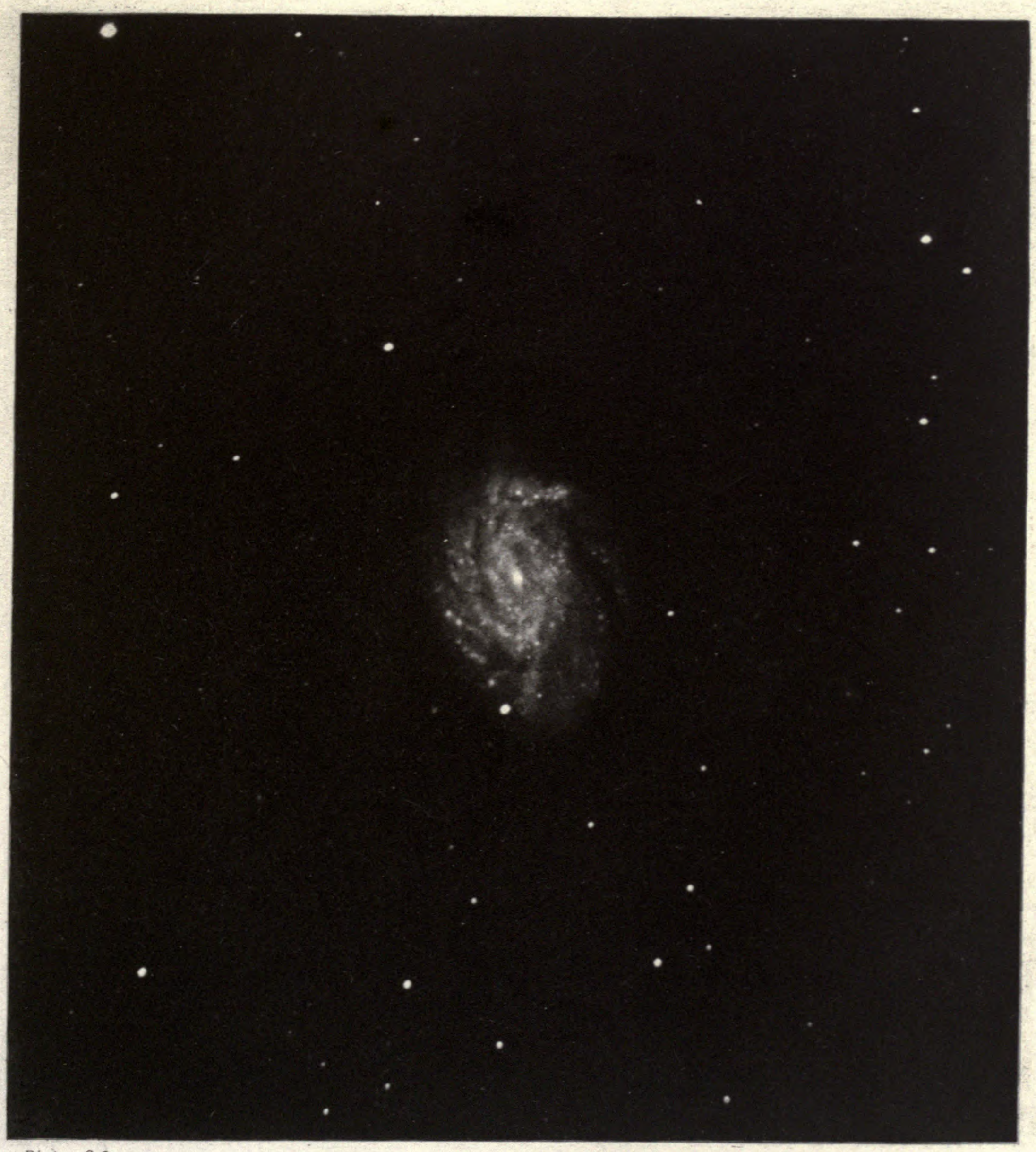


Plate 30 B

THE SPIRAL NEBULA H. II, 730, URSAE MAJORIS

Plate 31

THE NEBULA H.V 41, CANUM VENATICORUM

Plate 32

THE SPIRAL NEBULA M 99. COMAE BERENICES

Plate 33

THE SPIRAL NEBULA H.V 43, URSAE MAJORIS

Plate 34

THE SPIRAL NEBULA M 61, VIRGINIS

Plate 35

THE SPIRAL NEBULA M 100, COMAE BERENICES

Plate 36

THE NEBULA H. I 197–198, CANUM VENATICORUM

Plate 37

THE SPIRAL NEBULA M 88, COMAE BERENICES

Plate 38

THE SPIRAL NEBULA H.V 2, VIRGINIS

Plate 39

THE SPIRAL NEBULA H. I 92. COMAE BERENICES.

Plate 40

THE NEBULA H V 24, COMAE BERENICES.

Plate 41

THE NEBULA H.V42, COMAE BERENICES

Plate 42

THE SPIRAL NEBULA H.I 84, COMAE BERENICES

Plate 43

THE SPIRAL NEBULA M 94. CANUM VENATICORUM

Plate 44

THE SPIRAL NEBULA M, 94 CANUM VENATICORUM

Plate 45

THE SPIRAL NEBULA M 64, COMAE BERENICES

Plate 46

THE SPIRAL NEBULA M 63, CANUM VENATICORUM

Plate 47

THE SPIRAL NEBULA M 51. CANUM VENATICORUM

Plate 48

THE STAR CLUSTER M 3, CANUM VENATICORUM

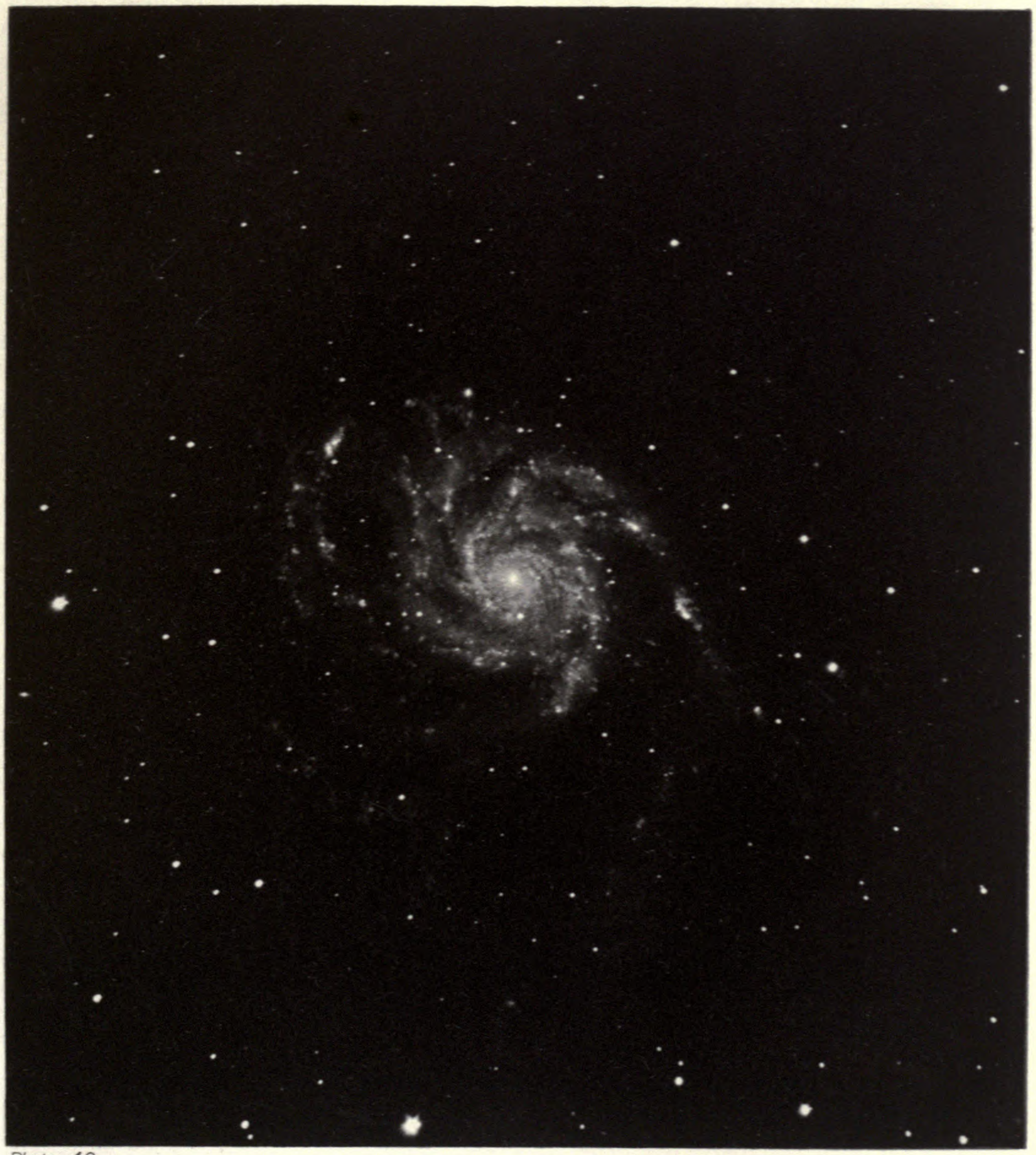


Plate 49

THE SPIRAL NEBULA M 101, URSAE MAJORIS

Plate 50

THE DOUBLE NEBULA H.II 751-752, BOOTIS

Plate 51

THE NEBULA H. I 215, DRACONIS

Plate 52

THE STAR CLUSTER M 5, LIBRAE

Plate 53

THE STAR CLUSTER M 13, HERCULIS

Plate 54

THE STAR CLUSTER M 12, OPHIUCHI

Plate 55

THE TRIFID NEBULA, M 20, SAGITTARII

Plate 56

THE NEBULA M 8, SAGITTARII

Plate 57

THE PLANETARY NEBULA H.IV 37, DRACONIS

Plate 58

THE HORSE SHOE OR OMEGA NEBULA M 17. SAGITTARII

Plate 59

THE RING NEBULA, M. 57, IN LYRA

Plate 60

THE DUMB-BELL NEBULA IN VULPECULA

Plate 61

THE ANNULAR NEBULA H. IV 13, CYGNI

Plate 62

THE SPIRAL NEBULA H. IV 76. CEPHEI

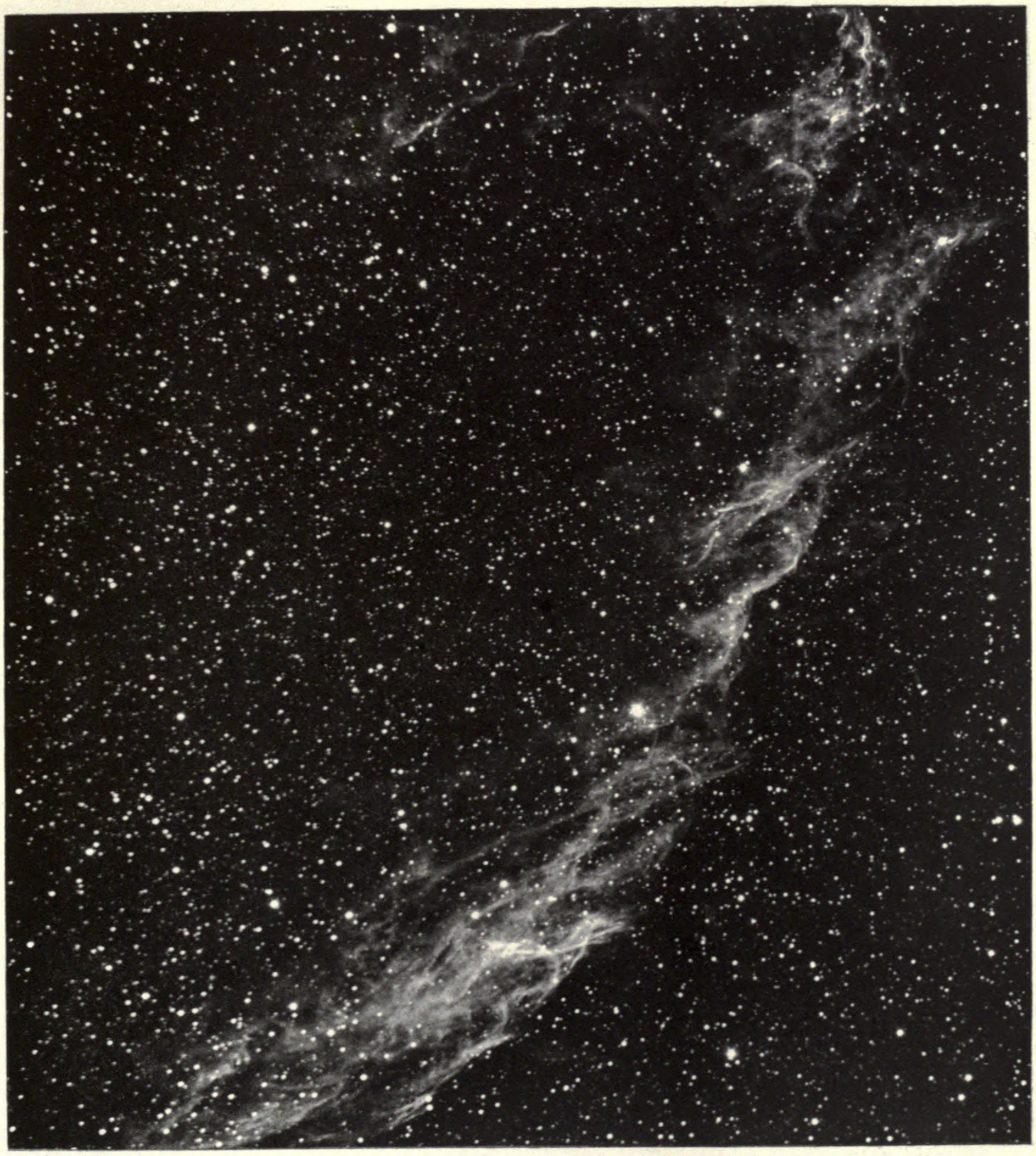
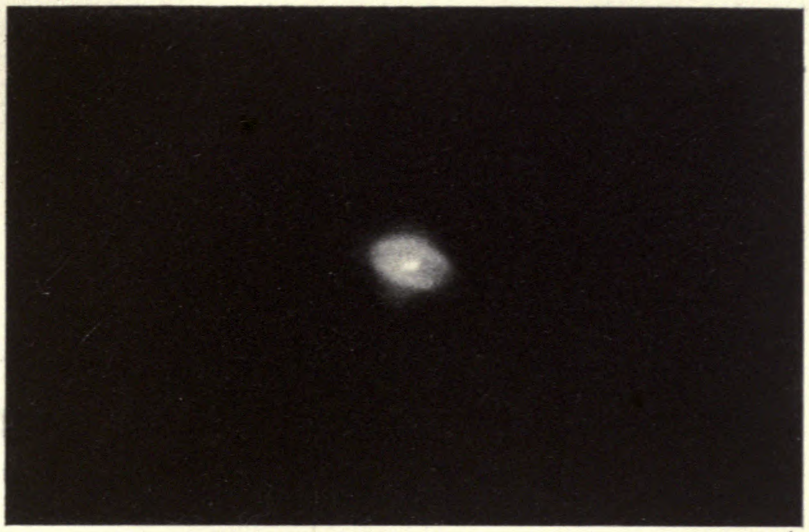


Plate 63

THE NET-WORK NEBULA IN CYGNUS



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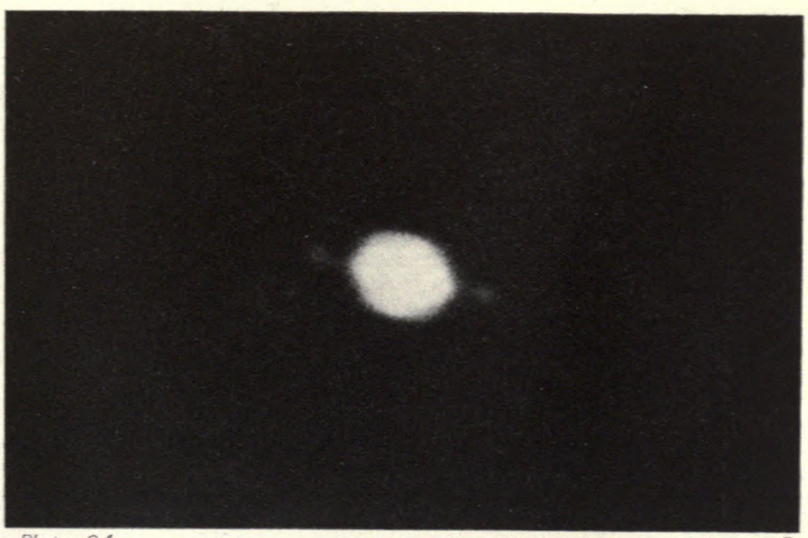

Plate 64

B

THE PLANETARY NEBULA H. IV 1, AQUARII

Plate 65

THE NEBULA H. IV 74, CEPHEI

Plate 66

THE NEBULA H.II 207, PEGASI

Plate 67

THE SPIRAL NEBULA H. I 53, PEGASI

Plate 68

THE SPIRAL NEBULA H. I 55, PEGASI

Plate 69

THE PLANETARY NEBULA H. IV 18. ANDROMEDAE

Plate 70

THE NEBULA H. II 240, PEGASI